MAY 1977 75 CENTS

Popular Science

The What's New magazine

The other story about the controversial **B-1 BOMBER**

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How they're extracting OIL FROM TAR SANDS

Building and using a HOME COMPUTER

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Inside the new INBOARD-OUTBOARDS

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Special section for homeowners: What you should know about hand grinders • Eye/face protectors • Register deflectors • And more

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MAY 1977
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Popular Science MONTHLY®

The What's New magazine

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PS READERS TALK BACK

Marine CB's not enough

The article "Marine CB" [Feb.] is well illustrated and informative, yet author William J. Hawkins overlooks one very important point. He states, "By mounting a CB radio on your boat, you've probably installed one of the best pieces of safety gear possible." This may be true; however, it is important to realize that VHF-FM marine radiotelephone is the primary means of communication via water. The U.S. Coast Guard and all ships underway, including police, continuously monitor the international-distress-frequency Channel 16 (VHF band). On the other hand, while Channel 9 (CB band) is set aside for emergencies, these are primarily land emergencies.

Also, VHF-FM radios have the capacity to receive continuous weather reports from the National Weather Service. Granted, on small lakes and rivers, CB'ers would be more likely to assist a boat in distress, as the Coast Guard or police may not have a station close by. For coastal and heavily trafficked inland waters, however, VHF-FM is the primary and best piece of safety gear to have aboard your boat, short of life jackets and compass!

Kirby Stross, State University of New York Maritime College, New York, N.Y.

Faster computer

In your February Science Newsfront, you described a computer capable of performing 50 million additions per second as "the world's fastest."

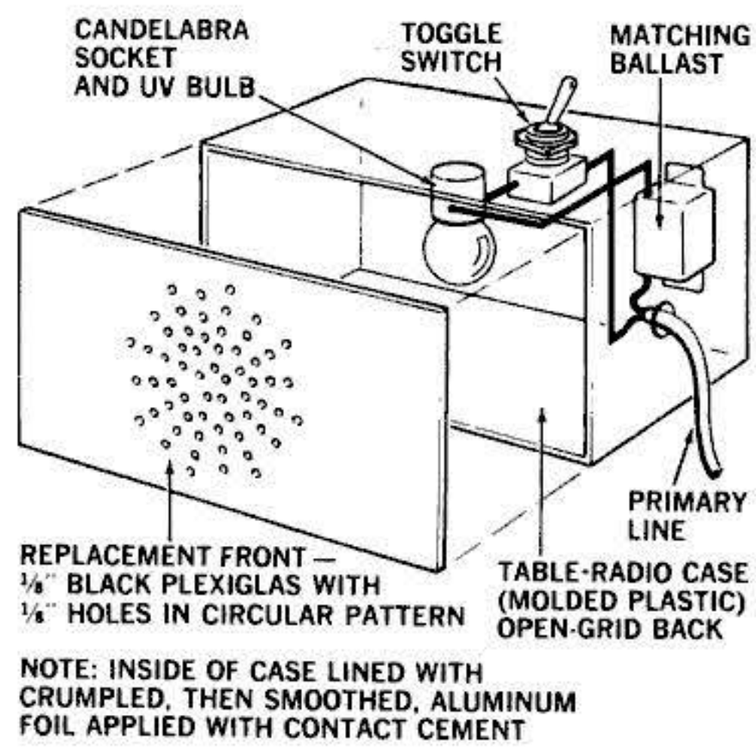
The world's fastest and most powerful computer is the STAR-100, manufactured by Control Data Corporation, which provides nearly 100 million results a second or about twice as many calculations as the machine mentioned in your story. In last September's record-setting demonstration, the STAR-100 in Control Data's Arden Hills (Minnesota) data center provided an average of 97,881,020 results per second while completing five runs using advanced-vector-technology processing. Included were 98,830,320 additions, 98,837,310 subtractions, 49,597,750 divisions, 98,532,570 multiplications, and 49,837,510 square roots.

Duane B. Andrews, Control Data Corp., Minneapolis, Minn.

DIY ion generator

I read with interest the Science Newsfront item [Jan.], "Negatively Speaking."

A few months ago I built a small ion generator as an experiment—after first asking my physician if there would be any benefits. His comment was a definite "yes."



The sketch above shows the generator. The total cost was less than five dollars.

Ted Averill, Burlington, Ia.

Racing with Kevlar

In reference to your February article on the uses of Kevlar for boat construction, the one application where Kevlar really shines is in racing shells. A "single" (27 ft. long) made of Kevlar weighs only about 27 lb. This is a very substantial reduction compared with singles made of wood frame and mahogany-veneer skin, which weigh 35 lb. or more.

We have been working with Kevlar

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Versatile, too. The big sliding door lets you load even big bulky objects. And the rear seat folds down to give you extra cargo space. How does it compare to a van? About as roomy, but a lot nicer. In fact, the interior of your VW Bus is beautifully finished. Comfort to us is not an option.

And talk about economy. Your Bus has a peppy fuel-injected 2-litre engine, yet it still delivers an estimated 28 mpg on the highway, 20 in the city with standard transmission in the 1977 EPA tests. (Of course, your actual mileage may vary depending on where and how you drive, your Bus' condition and whether you choose optional equipment, such as an automatic transmission.) And the '77 VW Bus comes with four-wheel independent suspension and radial tires for a smooth ride.

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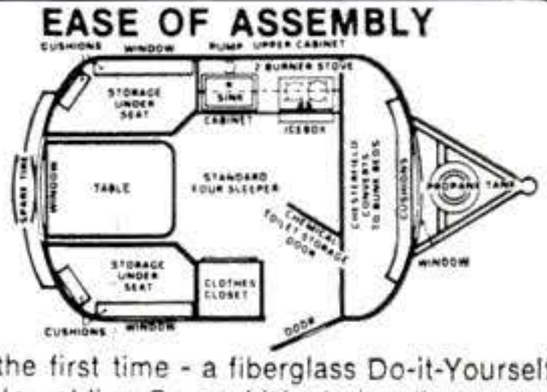

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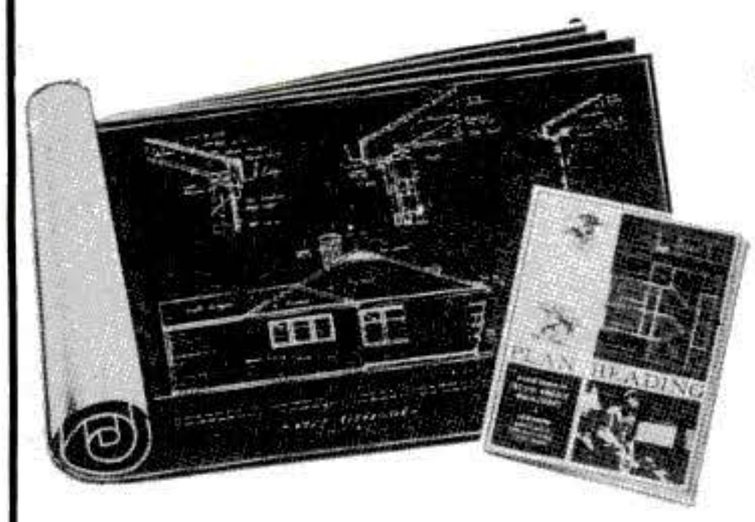

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PS readers talk back

[*Continued*]

for many years and pioneered many of its new applications. Presently we are molding Kevlar kayak and canoe paddles that are light, trouble-free, and very efficient. We are testing Kevlar sculls and sweeps featuring a flex shaft designed to store energy at the beginning of the stroke and release it as the boat accelerates. Tests indicate an increase of speed.

Perhaps finally a weapon to beat the East Germans and the Russians in rowing competition?

Joseph L. Hurka, president, Hurka Ind., Newburyport, Mass.

DAF + $4000 = Volvo 343?

It is with a sense of déjà vu that I read the article on the belt-driven Volvo 343 car [Jan.]: The December 1959 PS described a similarly engineered Dutch-built DAF automobile. It cost $1500. Since the price of the Volvo is nearly quadruple that, I suggest an update of your August '57 article, "What Makes Cars Cost So Much?"

Walter Koostra, Missoula, Mont.

Unweld that plate

In the November '76 article, "Doweling Jig," two sentences read: "A 2"-by-2" square of 3/16" plate is welded on the end. This plate is fastened with screws to the bottom of the motor base."

If this plate is welded to the top of the adjusting screw and fastened to the bottom of the motor base, it would be impossible to turn the adjusting screw. Am I right or wrong?

Stephan C. DeWitt, Ft. Wayne, Ind.

Bill Peters replies: You're right. The 2"-by-2" steel plate should not be welded to the threaded rod. My apologies.

Banned in BWCA

In response to Herbert Shuldiner's January Recreation Roundup item dealing with the recent U.S. Forest Service ban on snowmobiles in the Boundary Waters Canoe Area (BWCA) in northeastern Minnesota, the following is offered. Mr. Shuldiner's major points were as follows:

1) The ban was instigated despite opposition from local residents of the BWCA and nearby environs.

2) Why restrict snowmobile use when motorboats (with restrictions) are permitted in the area?

More than one million acres of the BWCA are included in the National Wilderness Preservation System, which was developed to preserve U.S. areas with recognizable wilderness qualities. . . . Wilderness areas are not intended to be preserved only for local residents. Every tax-paying citizen has shared proportionally in the purchase and management costs of these lands.

Implicit in the 1964 federal wilderness act was the notion that uses not compatible with preservation must not be allowed in wilderness areas. Hence the ban on snowmobiles is a step taken by the Forest Service to comply with federal law in maintaining the natural integrity of the BWCA.

It is to be hoped that our national heritage is better represented by the soothing sounds of wind in the pines than by the rattle of internal-combustion engines. I can only agree that it is unfortunate that motorboats are still permitted in the wilderness area.

Steve Apfelbaum, Champaign, Ill.

Mercedes fan

I very much enjoyed the brief article on the 1977 Mercedes Benz [Dec. '76].

It's nice to see that the Mercedes Benz has safety features that American cars don't have, such as the parking-brake linkage made of chain links instead of a solid rod so that it will not protrude into the driver area in the event of a collision.

One need only to compare the Mercedes Benz, intelligently designed by factory engineers, to American cars, with their ugly impact-bumpers, to see that the U.S. government is not qualified to make decisions pertaining to automotive engineering.

Francis Pivar, New Kensington, Pa.

"Simple fix" isn't always

A few months back Lawrence Betz had an article titled "Simple Fix Gives Long Life to Projector Bulbs" [Nov. '76]. It seemed like a reasonable idea to me so I modified my Honeywell movie projector and Kodak Carousel, both below 350 watts.

A close friend also liked the idea and asked me to modify both his Sawyer and Kodak Carousel slide projectors (with 500-watt bulbs). Instead of a simple fix I wound up with one shattered thermistor and two burned-out bulbs. The Sawyer worked initially, but after several tests the thermistor shattered and the bulb burned out. The Carousel didn't last 30 seconds.

The simple fix cost me $25 and wore a friendship a little thin around the edges. What went wrong? My own projectors are working fine.

Charles A. Kircher, Costa Mesa, Calif.

Since publishing that article, we have discovered a few important points. Further tests showed that substitute thermistors (Mr. Kircher sent us his cracked thermistor, a GB-26.5 from Oneider—not a Workman's FR-26.5 as used by Betz) were just at their tolerance point—which led to some of them fracturing from the load. (Thermistors that are normally acceptable substitutes for the ones we used are often not suitable for this application.) Furthermore, the simplified drawing was over-simplified, in that the bulbs should never operate without the fan. Parallel thermistors are not advised for extra loads—inconsistencies make one take

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What's more, at $10, it's an incredible bargain, and I'll even give it to you without asking you to risk *one penny!*

However, first let me tell you what I have.

I've got a *copyrighted job changing system* that you can use to move up in your field, or out to another field, but at significantly higher earnings.

It took myself and five other professionals two years and $250,000 to develop—*but it works!*

Furthermore, it doesn't require "genius" and it doesn't require "luck." All you have to do is put it into action.

The reason we developed it was because with 85 million employed, and 18 million circulating resumes each year, this area was ready for some revolutionary ideas.

We knew more people than ever owned prestige cars & yachts, summer homes and international retreats, as well as having securities, real estate holdings and lots of cash in the bank.

In short, many people in the U.S. are living good lives!

At the same time, however, the great majority have no excess cash, little job security, and are frequently restless, bored with their jobs, commuting long hours, and harrassed by inflation!

We asked ourselves how do people get to live the "good life"?

Well, we found that most successful people were there because they never wasted time in dead-end situations!

What these people did was to make crucial job changes, and *parlay* their higher earnings into small fortunes!

Take a look at the economics!

Do you realize that if you were to change jobs every 4 years, at an average annual increase of $4,000, and then put the increases in the bank at 6%,—that in 20 years you'd accumulate an extra *half million dollars!*

Getting raises is one thing, but getting significant increases because of job changes is a very important source for wealth!

The next question then, is how can you easily change jobs? This is where the unique system we've developed fits in.

Our system can work for anyone from $8,000 to $80,000. Do it right and you'll gain higher earnings, lifelong job security, but most of all, *everlasting* self confidence!

This is because once you've used it, you'll know you can *always* get a new job,—quickly and predictably.

Perhaps you're wondering why our system works? Well, it works because it's a *completely different approach,* based on totally new concepts.

But, also because it's simple, practical, and self-tailoring. You could start next week—and do it *without strain, confusion or worry.*

But, there is one catch! You won't be a success if you use old methods for dealing with recruiters & agencies, for answering ads & sending out letters, for handling interviews & negotiating salary.

To make more money without a hassle, you'll have to be willing to change. You'll also have to follow our system, have an open mind & have faith in yourself.

However, do this and a better life will be yours!

With our system, whatever you seek —a better job, a new career, higher pay, more satisfaction,—*I believe nothing can stop your success!*

Not age, sex, education, or even low earnings or past working history.

Personnel Magazine said we have a *"breakthrough."*

The National Public Accountant even said it was *"capable of catapulting any average person into a position offering much greater rewards."*

However, your best proof of our system is that we've already received thousands of letters from grateful customers.

Letters like one from a gentleman in California who wrote: *"In 4 weeks I changed jobs and raised my salary 33%! I wish I had it 10 years ago!"*

Another man from New York said *"I used one of your letters, sent 24 out, and got 13 interviews and 3 job offers!"*

Still another from California said *"In just 11 days I received an offer of $7,000 more!"*

I know this sounds almost too easy and I can't promise that you will do as well. But, then again you may do better!

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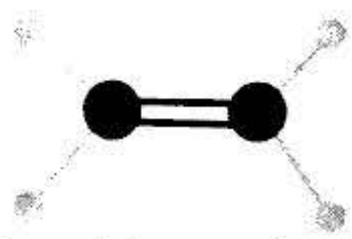
A short lesson in chemistry so you know what you're getting when you buy Mobil 1.

Take a look at one of the typical molecules in Mobil 1. It's a long chain of carbon atoms with one or two smaller chains hooked on near the middle. Right there you see the secret of Mobil 1's slipperiness: the long, snaky chains slither and slide across each other. That's the reason Mobil 1 lubricates so well.

How do we make molecules like this? We start with short, two-carbon molecules called ethylene and keep knitting them together chemically step by step.



The ethylene molecule. We start with this.

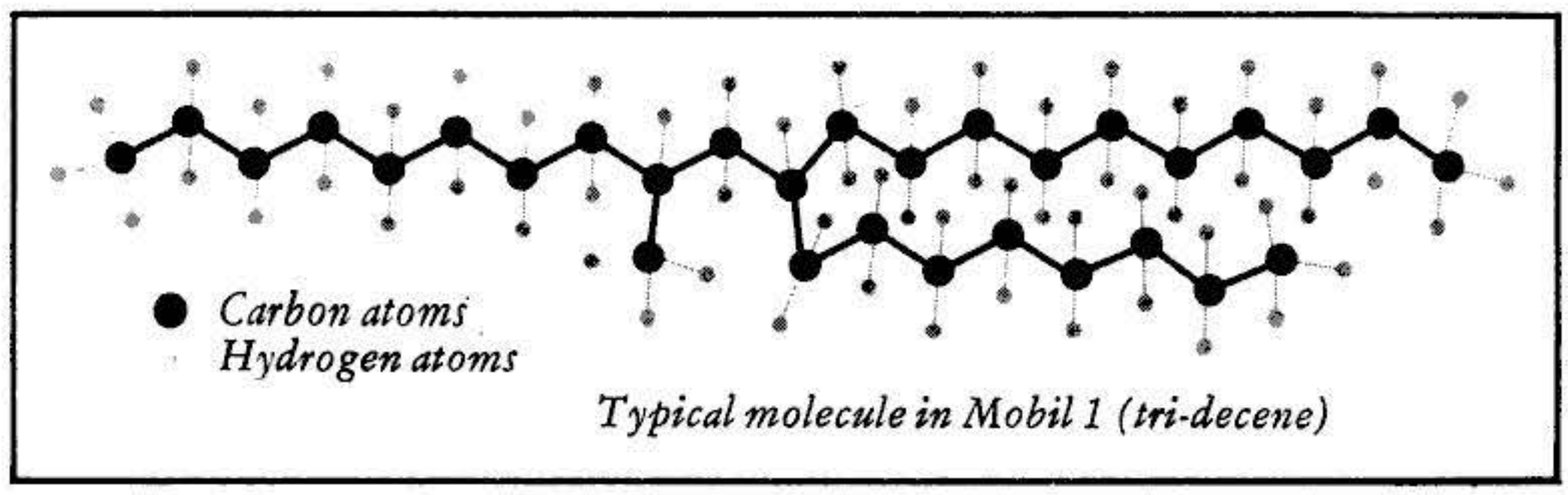
Now compare Mobil 1 with regular lubricating oils. These are made up of thousands of different molecules that nature put into petroleum. They're of all lengths, all shapes. There are small and large ones. Rings and chains. Multiple rings and multiple chains. Rings with attached chains.

With a mixture like this, there are problems. Each kind of molecule reacts in its own way to the changing conditions in the engine. When the temperature gets low, the large ones tend to become thick fluids or solids. When the temperature gets high, the lighter ones tend to boil off, and chemical changes can take place in the oil. Some molecules oxidize (burn) and turn into varnish-like products that can stick to engine parts.

Mobil 1 molecules are tailored to just the right length, just the right shape, so that they'll stay liquid under a wider range of conditions.

In cold weather, Mobil 1 remains fluid. In fact, your antifreeze will freeze before Mobil 1 will.

At high temperatures, Mobil 1 molecules are slow to vaporize, because they're neither too small nor too light, unlike regular oils whose lighter molecules boil off.



Typical molecule in Mobil 1 (tri-decene)

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Finally, to give Mobil 1 a complete balance of lubricating properties, we've added other substances. For instance, chemicals called esters, which are very good lubricants. We've also included a set of special additives that help control oxidation, rust and deposits and minimize wear.

Mobil 1 is so different, so advanced, that it invites questions. Here are some common ones people ask:

Questions and Answers on Mobil 1

What's the best thing Mobil 1 will do for my car?

Since it does a better job of lubricating the engine—reducing wear of its operating surfaces and keeping them clean—it helps maintain the engine in top shape and prolong its life.

We've studied many, many engines run on Mobil 1, examined their parts and seen the proof of this. Mobil 1 will take abuse that will break down regular oils. It has tremendous reserve lubricating power, beyond the life of regular oils. It's a highly dispersant oil, so stuff that can make piston rings stick and change the clearances of moving parts stays suspended in the oil where it can't harm the engine.

Can Mobil 1 actually save gas?

Yes. Mobil 1 lubricates better. Its molecules cling to metal ("adsorb"—as scientists say) and where metal squeezes against metal, it resists being forced out. So friction is reduced inside your engine. Mobil 1 is also "thinner"—has lower viscosity. Your engine doesn't labor against the drag of thick lubricants. For these reasons, more of the power in your gasoline is delivered to the wheels instead of being wasted on turning over your engine. And that means you get more mileage from your gas—up to ten miles more per tankful. You save money on gas by using Mobil 1.

Can Mobil 1 actually help me start my car better in cold weather?

Yes. Regular oils tend to thicken more in the cold. They generally contain waxes (long, straight-chain molecules), and in sub-zero weather these can turn solid in your engine. Imagine what a strain this puts on your battery and starter! Mobil 1 will circulate freely and lubricate your engine in very cold weather. It can help a well-maintained engine get started at 35 degrees below zero.

How low can it go? It will stay liquid at 65 degrees below zero—that's 97 degrees below the freezing point of water. Most regular oils jell at about minus 35.

Is Mobil 1 proven?

Yes. We've run it under extreme conditions in our test facilities. We've tested it in fleets of cars. In one test, Mobil 1 was run in a police car for 5,000 miles, then the used oil was run in a taxi for another 5,000 miles, then *that* used oil was run in a Cadillac for 5,000 more miles, topping it off only as needed. We found that after 15,000 miles, the used Mobil 1 could still do as good a job of protecting the engine as a brand new regular oil! Our testing goes on. We still haven't determined the practical limits of Mobil 1 before it needs changing.

Can I go longer between oil changes with Mobil 1?

That's a tough one to answer, because it involves more than just the oil. For instance, if your car is under warranty, you *should* change your oil according to your car manufacturer's instructions. That's generally at a lot fewer miles than Mobil 1 is good for. In this case, using Mobil 1 might be considered wasteful. But on the other hand, if you love your car...

After your warranty expires? Well, we're quite confident that Mobil 1 will protect your engine for 15,000 miles and more.

Is Mobil 1 compatible with regular oil left in my engine?

Yes. Completely.

Can I use Mobil 1 in an old car?

Yes, if the engine doesn't leak or burn oil. If it does, Mobil 1 will be used faster than a regular oil because it's thinner. Mobil 1 will do for an old engine what it will do for a new one, but what's worn will stay worn.

Is Mobil 1 really worth the extra cost?

Yes. You can get more mileage for your gas money. And it should be worth it to you to maintain your engine in top shape during the life of the car. You get faster sub-zero starting. You put less strain on your battery. You get excellent hot weather performance. And you can stretch the number of miles between oil changes.

We think that in the long run you won't just break even with Mobil 1.

You'll be miles ahead.

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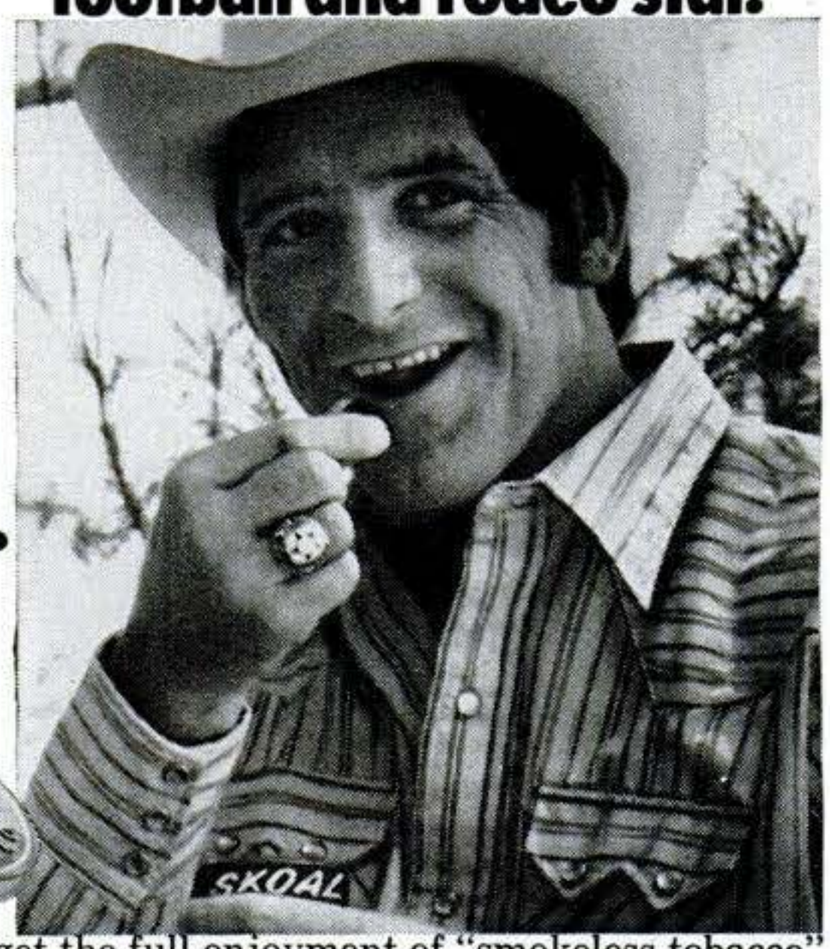
I love tobacco. I don't smoke.

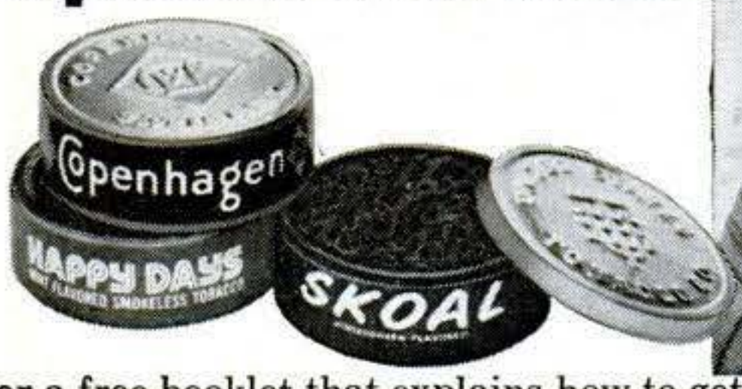
Walt Garrison, football and rodeo star.



You don't have to smoke to enjoy tobacco. All you need is a pinch of "smokeless" tobacco between your cheek and gum. You'll get full, rich tobacco pleasure.

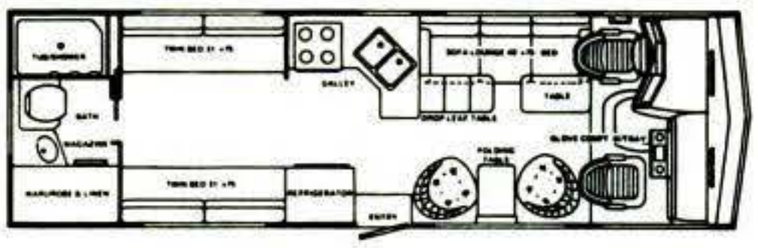
Look for it in three great brands. Skoal. Copenhagen. And Happy Days. Each is dated for freshness.

Smokeless tobacco. A pinch is all it takes.



For a free booklet that explains how to get the full enjoyment of "smokeless tobacco" —as well as a few free pinches that you can try for yourself—write to "Smokeless Tobacco," United States Tobacco Company, Dept. PS057, Greenwich, Conn. 06830.

A plan for you



Model R-27.5'. For leisurely travel, complete with entertainment center and overhead bunks in the rear suite. One of six plans.

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The luxurious Pace Arrow has a plan for you. Enjoyable vacations are made even better in the Pace Arrow of your choice. Select from six models in lengths from 24.5' to 27.5'. Master suite, entertainment center and side bath models are available. Make the 1977 Pace Arrow motor home part of your plan, today.

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PS readers talk back

[*Continued*]

on more current than the other. And, as if that weren't enough, we have learned through Educational Products Information Exchange Institute, a consumer union for educators, that tests by Eastman Kodak showed that the extended lamp life is not statistically significant.

Attic venting

You published an article about attic vent fans to cool your home some time back [May '74]. Your article mentioned only vents that were installed through the roof.

I recently saw a vent fan that could be mounted in front of an attic vent at either end of the attic. Are these fans as efficient as the roof-vent fans? They would be much less trouble to install.

Richard Moore, Edgewood, Md.

Al Lees replies: While it's not possible to make a comparison among attic-fan types because of the many variables, it's safe to say that a properly installed roof fan near the ridge will be more efficient than a comparable-size fan at the gable vent, though the latter may be all your house requires. The article you refer to appeared in our May '74 issue. We've an update in the works and would be glad to hear from anyone with a unique attic-venting installation.

Unguzzling natural gas

Last summer I decided to try to figure out a way to turn off the pilots on my gas range in order to make the kitchen cooler. I was surprised to find that each pilot had its own small valve, and all one had to do to turn the pilot off was to turn a small slotted shaft with a screwdriver.

Before I turned off the pilots, I was using on the average about 666 cu. ft. of gas per two-month period. After I turned off the two pilots, I used only 300 cu. ft. of gas per two-month period. Considering the present shortage of natural gas, maybe someone should instruct the public on where those valves are located and how to turn them off. Those who dislike the inconvenience of matches can obtain a piezoelectric sparker; they're said not to wear out.

Calvin I. Cuff, Brooklyn, N.Y.

Editor's note: More than 1500 readers have sent in their solutions to the "37-Year-Old Puzzle" [RTB, Feb.]. Darrell Huff is perusing them all and preparing a story—including selected puzzle solutions—for an upcoming issue.

Correction: In "Air Shocks for Motorcycles" [Feb.], the price of S&W's shocks was incorrectly quoted. They are $48 each ($58 each for chromed models).

Want to get something off your chest? Write "Readers Talk Back," Popular Science, 380 Madison Ave., New York, N.Y. 10017

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How to Achieve Total Financial Freedom In 1977

"Millionaires Are Not 100 Times Smarter Than You, They Just Know The Wealth Formula."

Mark O. Haroldsen
Millionaire in 48 Months

We've never met and probably never will, but I think we share a common interest. That interest is in achieving complete and total financial freedom.

Because of this common interest, I think we can be of great help to each other. You see, a little over twelve months ago my net worth reached the magic million dollar mark, and it only took me 48 months to achieve that.

That might not impress you, but if you had seen me four years ago, you might wonder how I did it. I lived in Denver then, in a cramped, tumbled down house at 2545 South High Street. My wife was expecting our second child and we were so broke we had to borrow $150.00 from a relative just to buy food and pay the rent.

By the way, I know I didn't make a million dollars because of my superior intellect — I barely got through Ames High School (Ames, Iowa) with a C average and I think that if you'll stop and think, you'll realize and agree, there is not a single millionaire that is 10, 20, or 50 times smarter than you, or that works 10, 20, or 50 times harder or longer than you.

Now, how can we help each other? I am willing to share everything I have learned and know that would help and guide you to achieve your own financial freedom and independence. But the only way I would ever give you my secrets, methods and formulas is if I benefit also. Because as you will find when you reach your ultimate financial goals, you really don't want to stop there but you are motivated to go and make more. It seems that most people who are charging for financial advice have studied how to "do it" but have never actually "done it" themselves. You will find as you read my formulas, that since I have actually achieved total financial freedom myself, that you will receive from me more than just the motivation to achieve your own financial independence, but a workable step by step plan to actually do it.

You may have seen part of my formulas described in various publications, such as the November edition of Nations Business, page 69. This work is entitled **How To Wake Up The Financial Genius Inside You.** The various formulas contained in the volume will show you exactly how you can do each of the following:

- buy income properties for as little as $100 down.
- begin without any cash.
- put $10,000 cash and more in your pocket each time you buy (without selling property)
- compound your assets at 100% yearly.
- legally avoid paying federal or state income taxes.
- buy bargains at one-half the market value.

If you apply these formulas and methods you will find in a very short time, you will be able to spend three weeks out of every month doing anything you care to do, and I think, at that time, you will find as I have, that spending several weeks on the beaches of Hawaii, or on the ski slopes of Colorado, or just sightseeing in Europe, or any other place in the world, you begin to understand what real freedom is all about.

Most people think that it would be impossible to do some of the things listed above. For example, to buy a property, and at the same time put $10,000 (or more) cash in your pocket without selling the property, or to buy a property with little or no cash down.

Believe me, it is possible and fairly simple. This is exactly how most wealthy people actually do make 10, 20, or 50 times more money than you do.

These formulas of mine do not have to be used with income properties only. They actually can be applied to virtually any asset.

While I was struggling on making my first million, I often thought how nice it would be to have the personal advice and counsel from someone like Howard Hughes or J. Paul Getty .

What would I have been willing to pay for this service? I can tell you one thing for sure, it would have been a lot more than the $10.00 that I'm going to ask you to invest in your financial future.

What will this $10.00 actually do for you? It will give you a complete step by step plan that you can follow to become totally and completely financially independent.

Please try to understand my dilema. I'm not a New York advertising agency, with all their professional skill and manpower to write a powerful and persuasive ad to convince you that I can make you financially independent. I am just somebody who has actually 'done it', and can really show you how to 'do it'.

What would you do, if you were in my shoes. You have in excess of $1,000,000 net worth, you have a desire to share your formula with others, because you not only have a simple, honest and workable method whereby others too can enjoy the riches of this land, but you also want to benefit and make money from sharing this information, so you can continue to grow financially.

I think you might do what I'm doing — that is to write a simple open letter to the type of people who share similiar goals as mine asking them to try the formulas for themselves, to see if they work as well as the claims described. Because, I know, as you would know if you were in my shoes, that if I can just convince you to test my formulas and methods, you will see for yourself that they will work as easily for you as they did for me.

It's really quite frustrating to have something so valuable as I know I have, but lack the skill to convince people to try it for themselves. I hope by my simple, direct approach, I can convince you to try my formulas.

It seems the majority of the people in our rich country lose, not because they lack intelligence, or even willpower, but because of procrastination, or lack of action — please don't be like the masses. Make a decision while you have this paper in your hands. Make a decision now to either act now and send for my material or immediately round file this paper. If your decision is to subscribe, do it now, not later. Otherwise, you may lose, just by default.

To order, simply take any size paper, write the words "Financial Freedom Package", and send it along with a check for $10.00 to Mark O. Haroldsen, Inc., Dept. E-722, Tudor Mansion Bldg., 4751 South Holladay Blvd., Salt Lake City, Utah 84117.

If you send for my material before June, 1977, I will also send you documents that will show you precisely how you can easily borrow from $20,000 to $200,000 at 2% above the prime rate using just your signature as collateral.

Mark O. Haroldsen

P.S. (If you are still somewhat skeptical, and believe me, when I started out I certainly was, because of the many people in the world trying to deceive others) I would encourage you to postdate your check by 30 days, and I promise and guarantee that it will not be deposited for at least those 30 days, and if for any reason you do not think that what I have sent you lives up, in every aspect to what I told you in this letter, send the material back, and I will quickly, without question, refund your money and send back your own uncashed check or money order. Also, if you would like to check a few of my references, I have listed some below.

Tracy Collins Bank & Trust, 4707 S. Holladay Blvd. Salt Lake City, Utah, Attn: Beverly Smith, Assistant Manger.

Charles Huber, C.P.A., 1850 Beneficial Life Towers, Salt Lake City, Utah. 801-531-8286.

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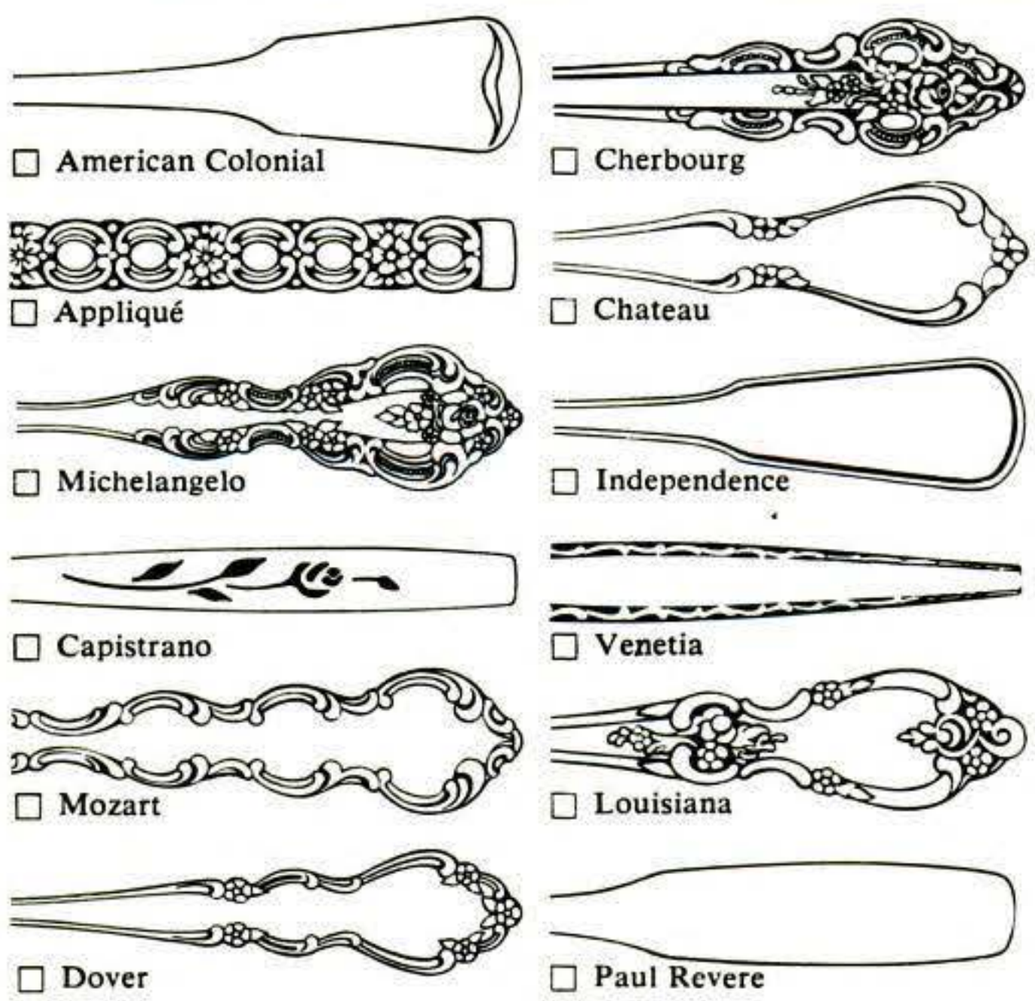
A gift givers' guide to stainless. Sample 50¢



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ONEIDA
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New **tree puller** increases yield 20%

A new tree harvester that extracts both taproot and stem makes a pine tree 20 percent more useful. The machine shears the lateral roots close to the taproot and then plucks the entire tree from the ground like a carrot. The concept was developed by Dr. Peter Koch at the U.S. Forest Service's Southern Forest Experiment Station in Pineville, La. The shearing apparatus is mounted on a John Deere 544 or Caterpillar 920 prime mover, which serves as a crane.

Two elements are central to its design: The first is a scissors-type grip equipped with a pair of tough horizontal knife blades that close at the ground line and bite several inches into the stem from opposite sides of the tree. The second element is a clamshell-hinged tubular shear, 22 inches in diameter, that is sharpened on the lower edge. With the scissors-grip as an anchor, the shear is forced vertically into the ground to a depth of about 11 inches, severing the lateral roots. At this depth, broad steps on opposite sides of the shear strike the ground to limit further penetration. Now, putting more force on the shear causes the steps to bear against the ground and the grip to rise about nine inches, jacking the tree free of the ground with the taproot attached. Finally, the entire tree is lifted into the air and bunched for skidding.

The harvester was designed specifically to extract the taproot with the rest of the tree. Until now, pine trees were felled above ground and their taproots left in the soil to rot—there was no way to harvest them. The taproot of a 15-30-year-old slash pine weighs about 20 percent as much as the usable bark-free stem (the part that grows above ground), and is suitable for pulping.

Pulling the taproots not only increases per-acre fiber production—it also significantly reduces the cost of preparing new sites for regeneration.—*Ed Kerr*

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Air Force Announces The Golden Opportunity Program

Now You Can Earn A Good Salary and a College Degree

Today, more than ever, look to the Air Force for the wide range of educational opportunities you need to succeed.

The Community College of the Air Force now has the authority to grant 2-year Associate Degrees.

It's a golden opportunity.

It means you can enroll in over 80 study areas ranging from accounting to computers, weather forecasting to police science, restaurant management to photography, mechanics to medical technology.

It's an opportunity to work toward an associate degree.

You can be proud of it. And you can use it. It could be a stepping stone to further education. It impresses prospective employers.

There are many golden opportunities in the Air Force.

If you're already headed for college, Air Force ROTC scholarships can help you through. The Air Force Academy offers one of the finest educations in the country. And if you're looking for a part-time job, don't overlook the Air Force Reserve.

Consider the Air Force.

Consider the Golden Opportunity Program. Learning and earning is a sure way to success and, if you're interested in serving your country and yourself, you should take advantage of it.

See your Air Force Recruiter for more information, mail in the attached card, or call toll free 800-447-4700 (Illinois: 800-322-4400).

AIR FORCE-A GREAT WAY OF LIFE

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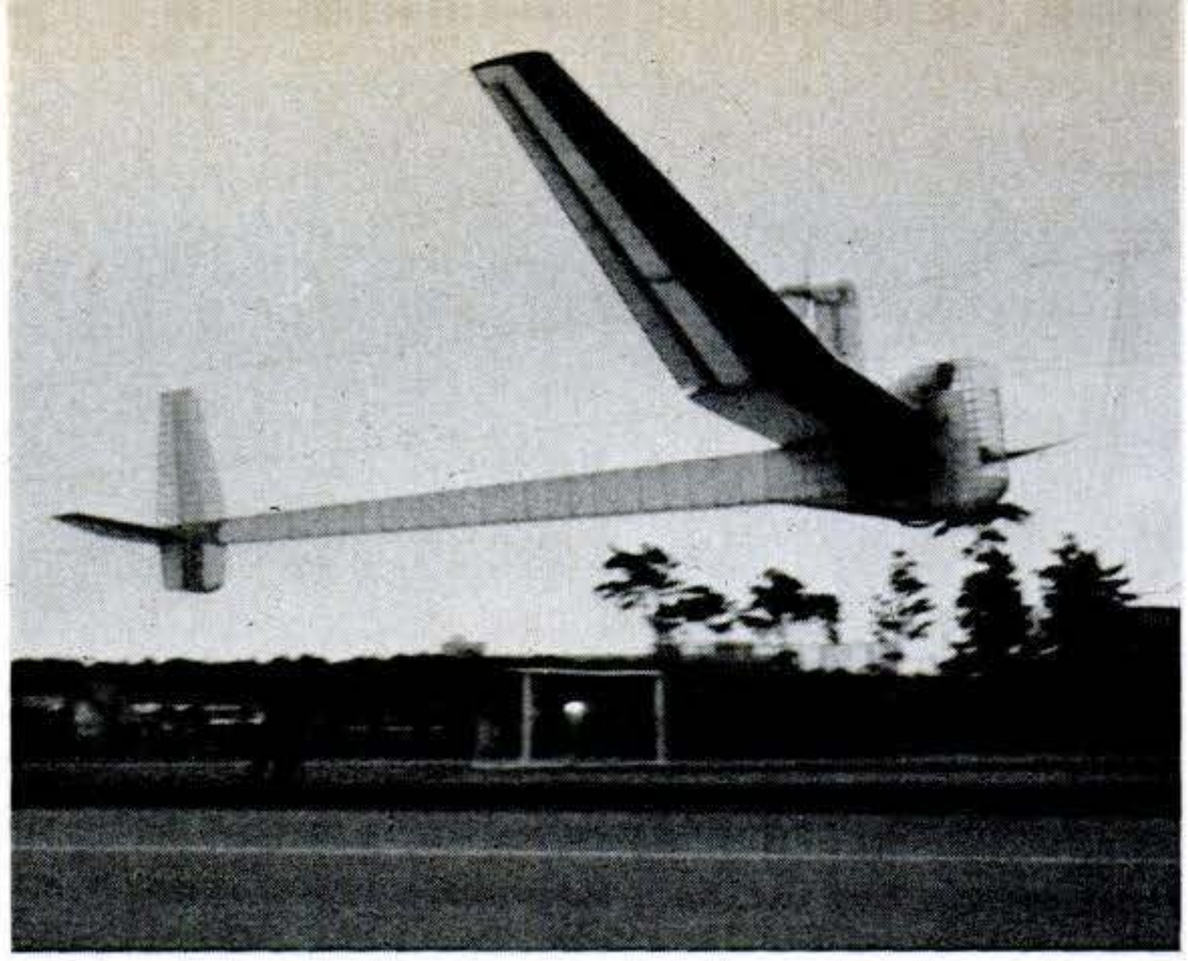
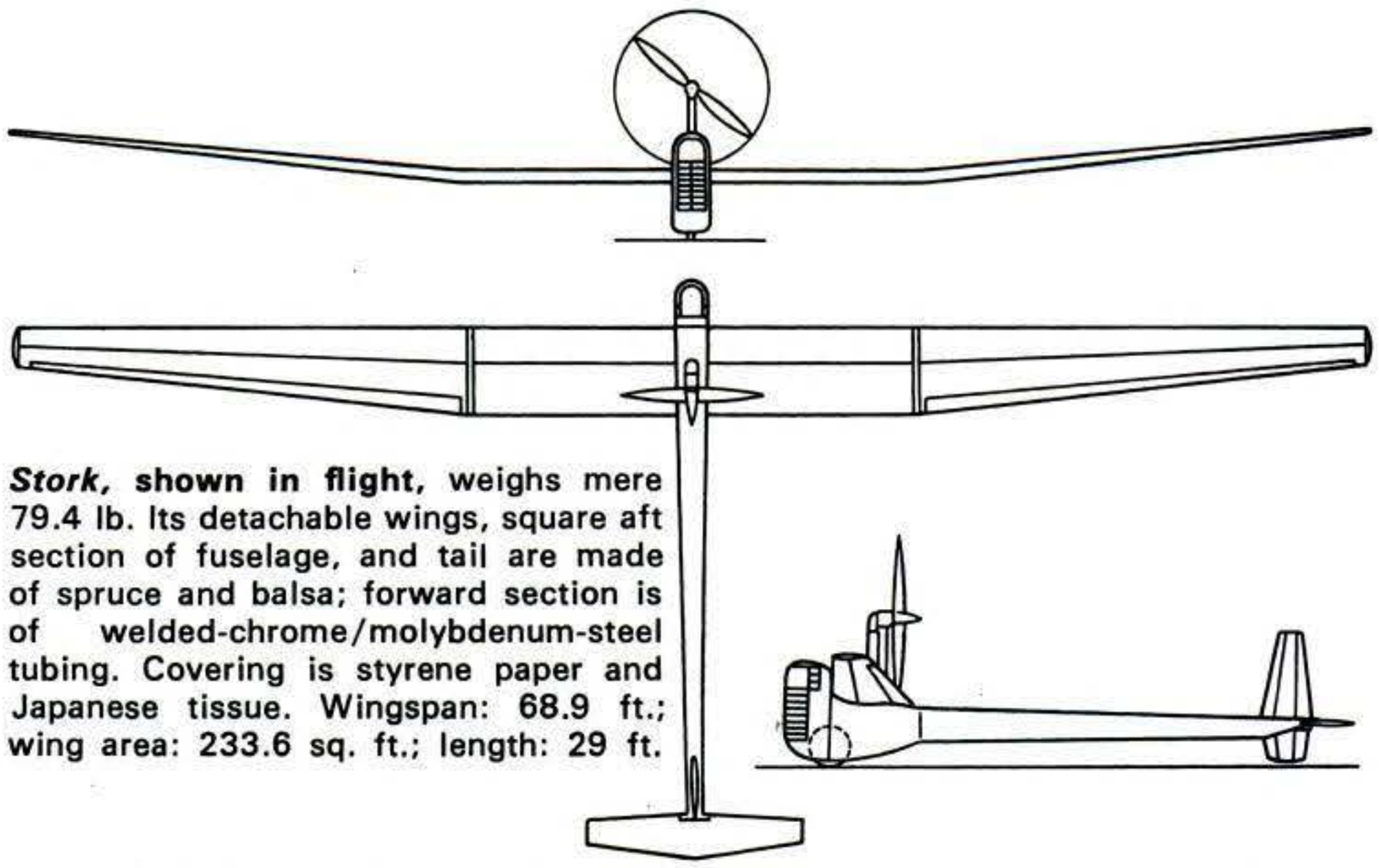
Man-powered aircraft
shatters flight records



The Stork, in Japan, may have the best chance yet at the $86,000 Kremer Prize

By PAUL WAHL



***Stork*, shown in flight,** weighs mere 79.4 lb. Its detachable wings, square aft section of fuselage, and tail are made of spruce and balsa; forward section is of welded-chrome/molybdenum-steel tubing. Covering is styrene paper and Japanese tissue. Wingspan: 68.9 ft.; wing area: 233.6 sq. ft.; length: 29 ft.

A flight that lasts four minutes 27.8 seconds and covers 2093.9 meters (1.3 mi.) at an altitude of about 10 feet may not seem like much. But it becomes very impressive when the plane is powered only by the pilot's muscle. Takashi Kato, a 21-year-old engineering student at Tokyo's Nihon University, made this flight on January 2 at Shimofusa naval air base in Japan.

He broke the world records for man-powered flight (distance, 1071 meters; duration, one minute 47.4 seconds) set in England on June 29, 1972, by RAF Flight Lieutenant John Potter in the *Jupiter*. Kato's spectacular performance has made his college's pedal plane, *Stork B*, the leading contender for the famed Kremer Prize.

This £50,000 purse ($86,000) goes to the first entrant whose man-powered aircraft can fly a roughly two-mile figure-eight course around two markers a half-mile apart.

Twenty such craft have left the ground since the prize was established in 1960, but not one has yet even attempted to fly this course. (The Kremer Competition is named for British industrialist Henry Kremer, who donated the money, of course.)

Dr. Hidemasa Kimura, whose mechanical-engineering students at Nihon U. designed, built, and fly the *Stork*, says they will try out the craft in the near future. Their chances look very good. Pilot Kato, who trains by daily pedaling a roller-mounted bicycle for an equivalent of 50 km (31 mi.), terminated his record flight only because he was nearing the end of the landing strip. He told witnesses that he could have flown much farther.

As early as June 1976, *Stork* accomplished the essential 180° turns —something no other man-powered aircraft had done since *Puffin II* in the 1960's.

The *Stork* team, headed by designer Junji Ishii, draws upon the experience gained by building and flying eight man-powered aircraft at Nihon U. since 1963.

In a *PS* interview [Feb. '74], John Potter was asked if the Kremer Prize could be won. He replied: "I'm sure it's feasible. Our machine [*Jupiter*] weighs 146 pounds. If you could get that down to 100 or even 110 pounds, I'm sure we could get it around that figure eight without any great difficulty."

With *Jupiter* as a model, Ishii created *Stork*—essentially a compact version of the British plane. The wingspan is 68.9 ft., compared with 80 ft. for *Jupiter*. The *Stork* weighs only 79.4 lb., and its maximum takeoff weight is 207 lb. (the pilots are all lightweights).

Stork is a cantilever shoulder-wing monoplane. The landing gear is a 27-inch bicycle wheel driven on the ground by pedals; there are bicycle-type brakes. A chain drive transmits pedal power to the 8.2-foot, solid-balsa, pusher propeller. With the prop turning at 210 rpm, flying speed averages 19.2 mph. The control bar pivots to operate the ailerons and rudder, and has a twist-grip for elevator control.

Between March 12 and June 4, 1976, *Stork* made about 40 flights; 11 of these were longer than a quarter-mile. Slight modifications were then made, and between November 24, 1976, and January 4, 1977, the improved version, *Stork B*, made 43 flights. Nine of them were greater than a half-mile (three of them were nearly a mile); and two, including the officially witnessed record flight, exceeded two kilometers (1.24 mi.).

Dr. John H. McMasters, a leading authority on ultralight aircraft, told me recently: "*Stork* probably is the best man-powered plane ever built. If this machine doesn't win the Kremer Prize, maybe it can't be done." PS

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The Continental by **THETFORD**

RECREATION ROUNDUP

By HERBERT SHULDINER

Scout Parade

International Harvester is sitting on the sidelines during the van revolution because it doesn't make any of the vehicles that are enjoying a fantastic sales boom now. But International does make pickups and four-wheel-drives, and it is starting to have some impact in this area with many exciting new models.

I recently spent a day at International's proving grounds in Chandler, Ariz., where I had an opportunity to see and drive a number of these new rigs. I was impressed. The most exciting new offering from the company is the Scout SS-II (top) "intended for those who regard off-road four-wheel driving as an exciting sport," says F. J. Wending, International's light-truck marketing manager. The barebones SS-II comes without a top, passenger seats, or doors. It does have a heavy-duty roll bar, front sway bar, and power disk front brakes.

International has also introduced a new convertible pickup—the Suntanner (lower left). It has a white vinyl top that you can unsnap when you want to let the sun shine in. It's available as a four-wheel-drive with automatic locking hubs. Other options: cargo tie-down rails, cruise control, heavy-duty rear step bumper with ball hitch, or a Class-III trailer-towing platform.

International—while it has no vans—is doing its best to make its station wagons look a lot like vans inside. The Scout Street Machine (lower right) has a gussied-up interior package that comes close to looking like the inside of a van conversion. It has two front swiveling bucket seats, and a foam-padded, carpeted rear. Ceiling, side panels, seats, and doors are covered with a tweed fabric designed to match the shag carpeting. The Street Machine's exterior has distinctive accent striping and there's an overhead sun roof. The package can be ordered for either the 100-inch wheelbase Scout II or the 118-inch wheelbase Traveler station wagon.

Light-truck recreation boom

Pickups account for about 25 percent of today's personal-vehicle sales, and they're especially popular for recreational use—even though most are gas-thirsty. Big exceptions are the Japanese-built light pickups that commonly top 30 mpg. The champ in this respect is Ford's Courier, which has recently been revamped.

The Courier gets 41 mpg on the high-

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way—even with a new seven-foot box and 113-inch wheelbase. The shorter six-foot model has also been revamped and now has a stretched wheelbase that's 107 inches long—2½ inches longer than last year's model.

For '77, Ford offers a youth-oriented "Free Wheeling" package that really zips up the pickup's looks, and makes it more appropriate for rough-country use. Included are a black front brush guard, blacked-out hood, and a rear-mounted black bed protector. It also has distinctive striping and lots of passenger-car-type options in the cab.

Also new for this year is the 2.3-liter engine (standard engine is 1.8 liters).

Trailer anti-theft device

When you lock this hitch ball in a coupler, thieves can't set the trailer on another ball hitch and tow it away. Free-floating steel pins on the ball fit into

holes drilled in the coupler. The only way you can remove it is with a key.

All that's needed to install the device are a template and jig. The pins cannot be drilled out or driven in with a hammer and punch.

The Sentry Ball is $16.95 for small sizes and $19.95 for big ones. From Recreation Creations, 210 West Oldfield St., Lancaster, Calif. 93534.

Bike trail

The East Coast Bicycle Congress has created an 800-mile bike trail from Richmond, Va. to Boston, Mass. It was designed as an extension of the Bicentennial Trans-America trail. The "Appalachian Trail for Bicyclists" uses lightly traveled back roads and skips mountain ridges and populated areas.

A guidebook is available for $4.95 from the East Coast Bicycle Congress, 5300 Akron St., Philadelphia, Pa. 19124.

Good reading

The 160-page *Motor Home Buyer's Guide* by Ginny Ade is one of the best introductions I've read on this subject. It's a good reference for anyone who's planning to buy a motor home, because it tells how to judge the complex systems these rigs contain. There's also a handy checklist for ordering the items you need. You can get a copy for $1.95 from Winnebago Industries, Inc., Consumer Information Dept., 1909 East Cornell, Peoria, Ill. 61614.

The *Coleman Camping Annual* 1977 has some good tips on outdoor living by some of America's leading outdoor writers. You can get a copy for $1 from the Coleman Company, 250 N. St. Francis, Wichita, Kan. 67201.

Avalanche Handbook is a new guide by the U.S. Forest Service designed to help skiers and mountain climbers. It's available for $3.95 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. PS

SNAPPER FAST.

There's only one way to finish your lawn Snapper fast. And that's with a Snapper mower. You can choose one of our V-Series mowers. Or the famous Snapper Comet. Or the new "High Vacuum" Riding Mower with the optional Bag-N-Wagon that holds 30 bushels. All of them are designed to help you finish your lawn Snapper fast. So that you can spend more time doing what you want to do.

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Pinball Computer

Your home, apartment or office can become an action entertainment center with America's first commercial-home pinball machine.

It's you against a computer. And the action and excitement from Fireball, your own computerized pinball machine, is nothing short of spectacular.

Fireball's computer replaces many of the mechanical, scoring, conventional electronics and sensing devices of a standard pinball machine. It's a dramatic change in pinball devices and the start of a new consumer electronics revolution.

DESIGNED FOR ACTION

Fireball contains flippers, bumpers, thumpers, flashing lights, sounds and a full-sized playfield. The glass covering the playfield is safe, shatterproof and specially tempered.

From one to four players can compete. Turn the unit on and simply program the computer with the number of players by pressing the start button up to four times. Each player's score is kept separately in a memory and appears on the display for each player's turn and at the end of the game.

The ball is automatically ejected and you pull the plunger to project it into action. The ball bounces from side to side from bumper to thumper. Lights flash and the scoring begins. You use the separately controlled flippers by pressing the flipper controls on the sides of the playfield which are low enough so that even a five year old can reach them.

Flip a switch and Fireball can be programmed for beginner or advanced skills although pinball is the only game everybody knows how to play within seconds after they step up to a machine.

"WE'RE IN THE MONEY"

The thrill of winning a bonus score or extra ball is enhanced by Fireball's songs and scoring tones. The computer's synthesizer plays seven songs—everything from "We're in the Money" when an extra ball is awarded to "The Party's Over" when the game ends. Various scores sound five additional tones making the game a total sight and sound experience. A volume control lets you keep it loud at a party or turned down in quieter surroundings.

COMMERCIAL PARTS AND FEATURES

Fireball contains the same heavy-duty devices and scoring features as a commercial pinball machine. The game has a tilt feature—tilt Fireball and a tilt sign glows and the scoring stops. The full-sized, full-color commercial playfield even has a special friction silk-screened surface so the ball will roll and not slide. Fireball differs from an arcade unit only by the start button which has replaced the coin slot and its new electronics. In fact, all future commercial machines will resemble Fireball within a year.

MANY NEW FEATURES

Fireball's computer is as powerful as the million dollar IBM computer sold in 1964. The solid-state LED scoreboard replaces the old electromechanical pinball scoring wheels so Fireball's backboard is thinner and its scoring more reliable. Its memory not only keeps track of everybody's score but the exact playfield configuration and extra bonus balls—something present arcade games can't do.

The American-made Bally Fireball—the first computer pinball machine designed for both home and office entertainment centers.

Although the playfield is just as large as the commercial machines, the entire unit has less weight, less bulk, and practically no service requirements making it ideal for the home or office. It takes up a space 2 feet by 4 feet and weighs 160 pounds.

HOW TO JUSTIFY PINBALL (TAKE THIS TEST)

If you paid more than $600 for either your TV set, stereo system or pool table—you should consider a pinball machine. You'll have more fun and action than watching TV, listening to your stereo or playing pool.

And when guests pop in, your Fireball will be the talk and highlight of their visit. Your TV and stereo are used primarily for private viewing or listening. Your pinball machine is for all times—from your personal family enjoyment to big parties. It's the great new idea in home entertainment.

TAX DEDUCTIBLE

Consider Fireball for your office as either an executive toy or a free new benefit for your office or factory employees during their breaks. You get both an investment tax credit and depreciation. Fireball combines participation, action and entertainment. A pinball machine is so intriguing that people pour dollars into them at arcades. It requires skill, sharpens responses and can become the single most talked about entertainment product in your home or office.

LASTING PLAY VALUE

Fireball, unlike the new TV games, is partially a game of chance and thus can never be mastered. Even an experienced professional can lose to a youngster. A daughter can beat her father, grandma can beat grandpa and the surprise of an upset is what adds to the long lasting play value. A professional pinball machine is an amusement game that you rarely get tired of—no matter how good you get, no matter how long you've played. Ask any arcade operator. His customers will tire of his video games which he continually rotates with newer models but his pinball machines are played and played and played.

Don't be confused. There are other games made by toy designers selling for one half the price. Fireball is not a toy and is built by a company that specializes in pinball machines. With all its sophistication it is the most service-free, quality pinball machine ever produced.

When you buy an expensive product you must be absolutely satisfied that you get the service and a solid company standing behind your purchase for many years to come. Fireball is backed by a substantial company, Bally—in business since 1931 and now the world's largest manufacturer of coin operated amusement games. JS&A is America's largest single source of space-age consumer products and also a substantial company—further assurances that your investment is well protected.

A FRANK DISCUSSION OF SERVICE

Fireball is a solid-state computer with its electronics condensed on integrated circuits—all hermetically sealed and all pre-tested for a lifetime of service. Fireball is also self-diagnostic. Let us say something goes wrong with the system. Simply press the test button on the back panel of your machine and the exact problem is displayed on your scoreboard in digits. Check the instruction booklet and simply remove the designated plug-in circuit board, light bulb or part and send it to the service department closest to you for a brand new replacement. Even your TV or stereo isn't that easy to repair.

Please don't think service requirements are common. They're not. But we wanted to assure you that service was such an important consideration in its design that Fireball practically repairs itself. And any defective component will be replaced free-of-charge during its one year limited warranty.

SHIPPING AND THE TRIAL PERIOD

Each Fireball comes in two sections with four metal legs. The two sections quickly bolt together with the top portion also plugging into the bottom to make all electrical connections. Within minutes after it arrives, your unit is ready to operate.

Attach the metal legs, plug it in and start playing. Don't even read the instructions on how to play it—you should know how within minutes. Then after you've played Fireball for awhile, go to your local arcade and play a standard $1500 pinball machine. It's only then that you'll realize how much more value you are getting with Fireball.

But let's be realistic. What if you don't like what you get? Simple. A toll-free call to JS&A and we'll arrange for the pick-up of your unit and we'll pay all the pick-up and return costs. And you can play Fireball for one month before you make up your mind.

A GUARANTEE OF SATISFACTION

The cost for your own pinball machine is $795 (Illinois residents add $39.75 sales tax) plus the freight which you pay upon receipt and which will run approximately $34 from our facilities in Northbrook to Los Angeles or less if you live closer. You can order Fireball with any major credit card by calling our toll-free number or you can send your check for $795 to the address shown below. We will then promptly ship your unit and advise you.

We back Fireball with an outstanding service program made possible by plug-in commercial components. We provide the opportunity to use Fireball for one month without obligation and if 1) it does not live up to every one of your expectations 2) for any reason you get tired of playing it, or 3) you don't find it more challenging after one month than when you first played it, give us a call and we'll pick it up at your door at our expense and refund your money. We provide fast service turnaround time should service ever be required and we have been in business for over a decade providing the same conscientious service that has built our company into America's largest single source of quality space-age products.

Why not let the fun and action of your very own pinball machine add to your home or office entertainment picture? We'll make just trying Fireball the best entertainment move you've ever made. Order one at no obligation today.

JS&A® NATIONAL SALES GROUP

Dept. PS One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-9000

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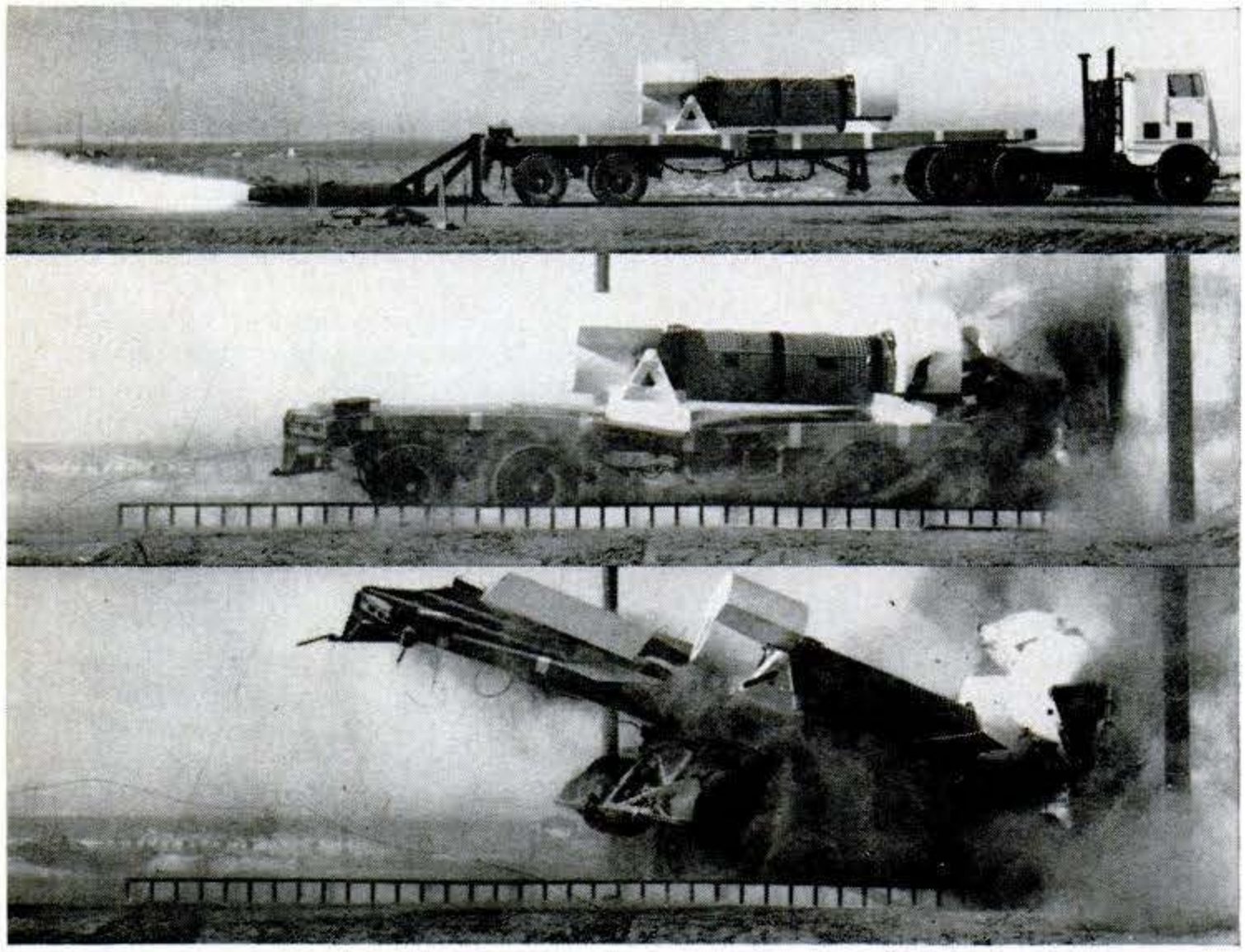
SCIENCE NEWSFRONT

BY ARTHUR FISHER

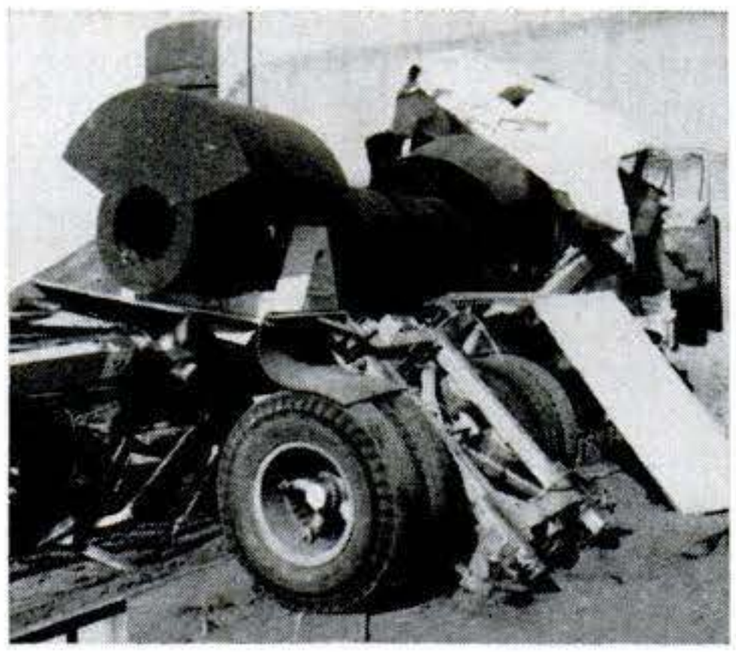


Crash program for nuclear safety

This spectacular photographic sequence records what would happen to a container for spent nuclear fuel involved in a catastrophic accident. The reassuring answer is: minor surface damage only. The test, first in a series of four to be conducted at Sandia Laboratories in Albuquerque, N.M., used a 22-ton nuclear-fuel shipping cask, which actually held an unirradiated, 700-pound fuel element bearing 477 pounds of uranium—20½ pounds of it fissionable U-235. The fuel element was designed for use in the nuclear-powered merchant ship, NS Savannah.

In the top photo, you can see the cask mounted on a tractor-trailer rig, which rides Sandia's rocket sled track. Four surplus Hawk rockets ignite, hurling the rig down the track and into a 10-foot-thick concrete target at close to 61 mph. As the pictures show, the tractor-trailer is utterly demolished. The fuel cask, however, survived intact. The cask is made of stainless and carbon steel, and lined with lead shielding. It is also equipped front and rear with "impact limiters"—a kind of shock absorber made of balsa wood and sheathed in 11-gauge steel.

The crash program, a $2 million ERDA project, calls for three other high-speed tests this year: a tractor-trailer crash at 80 mph; a speeding locomotive crash into a fuel cask at a simulated grade crossing; and a crash—into a massive concrete abutment—of a special railcar carrying a spent fuel cask, followed by a fire.



Largest windmill blade

Fifteen stories, 17 tons. That's how big a new windmill blade will be when it is completed by Kaman Aerospace Corp. of Bloomfield, Conn., as part of ERDA's quest for large-scale energy from the wind. This King Kong of blades, 150 feet long, will be typical of the blades used in future windmills generating 1.5 to two megawatts of electric power—enough for hundreds of homes. Engineers believe a wind turbine using two such blades could generate two megawatts in average winds of 14 mph. The blades that power ERDA's 100-kilowatt wind turbine at Sandusky, Ohio, are 62.5 feet long. [See "World's Biggest Windmill," PS March '76.] NASA's Lewis Research Center, which built the Sandusky wind machine, will manage the new project.

The new blade will be made primarily of glass fiber, using techniques that borrow from helicopter-blade fabrication. The largest helicopter blade, however, is only about 55 feet long. The $2 million contract with Kaman Aerospace calls for the design, construction, testing, and evaluation of the blade.

The push for giant wind turbines stems from studies showing that larger machines can be more efficient at generating electricity. General Electric is designing and building two 1.5-megawatt wind machines to be installed and tested for NASA and ERDA in 1978-1980.

The cranes are flying

Anticollision devices for airplanes have been repeatedly designed and recommended. But for overhead cranes? A news release from Stockholm informs me that the prudent Swedes have invented a microwave device operating on the Doppler radar principle (which measures the relative velocities of objects) to avert collisions between overhead cranes riding on the same rails. It's called Colwar and is sold by Amlab AB of Nynashamn.

Inventor's reward

I am constantly bombarded, as you might suspect, with letters from inventors convinced they have solved the energy crisis. A discouraging number of these seem to be perpetual-motion machines in disguise; many others are vague concepts with no real engineering design; some seem genuinely interesting to us, but need financial backing for more R&D before their usefulness can be demonstrated.

It happens that our government is looking for inventions in that last category. It has an energy-related inventions program, under which inventors submit their ideas to the National Bureau of Standards (NBS) for evaluation. And any that the NBS finds promising are turned over to ERDA with the recommendation that they are worthy of government support.

As an example of one such happy outcome, a Massachusetts inventor, Joseph Yater, has recently received a $40,000 contract from ERDA's Division of Physical Research to investigate an offbeat idea for the conversion of heat to electricity. Mr. Yater would like to build a device incorporating a large number of tiny resistors in microcircuit modules, with a density of perhaps one million per square centimeter. Resistors produce randomly varying voltages as a result of electron motion, an effect that is increased with heating—solar or any other.

Useful electric power could be produced if the electrons flowed in one direction only, which might be effected with a rectifying diode cooler than the resistor. The ERDA contract is for a con-

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ceptual design of the prototype device Yater would like to build.

Like to submit your ideas to the government? Ask for an evaluation-request form from the Office of Energy-Related Inventions, National Bureau of Standards, Washington, D.C. 20545. More than 4000 inventions have been submitted since the program was instituted in 1974.

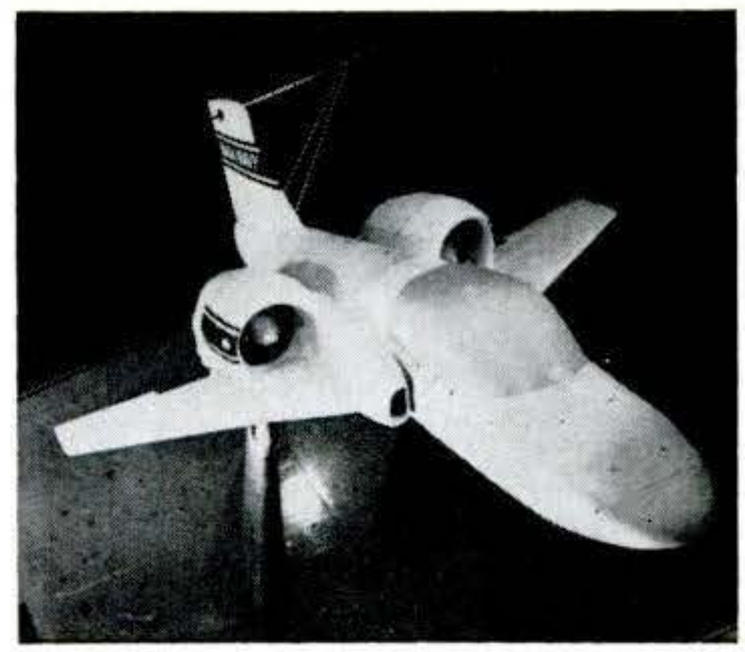
Solar energy for mobile homes

An experimental double-width mobile home with 1000 sq. ft. of living space has been designed with a unique solar-heating system by researchers at ERDA's Los Alamos Scientific Laboratory. Pictured above, the home has 340 sq. ft. of flat-plate air-heating solar-collector panels mounted on its south wall. Solar heat provides about 80 percent of the unit's space heating and hot water; electric heating is used as a backup. The system forces cool air across the collectors to absorb heat. Excess heat is held in a simple but workable storage system —1500 glass jars filled with water and stacked apart from the living area.

Engineers at LASL figure that homeowners in the sunny but cool Los Alamos climate could save about $420 per year using their system instead of electric heat. They estimate the solar mobile home could be produced for about $25,000, with the solar system costing $5000 of that total. Other calculations: This system would provide 80 to 100 percent of heating and hot-water requirements in cities like Phoenix and Fort Worth, and from 40 to 60 percent in Boston, Seattle, Ottawa, North Dakota, and Wisconsin. About 10 million people now live in about four million mobile homes, according to the Manufactured Housing Institute, and that number is expected to increase.

Space litter

A record number of man-made objects whirled through space at the end of 1976: The official tally, made by NORAD (North American Air Defense Command), is 1117, most of them remnants of the breakup of satellites. Only 161 objects were actual payloads—satellites carrying functioning instruments. When things fall apart in space, they really go to pieces. In September, for example, a part of Pageos, a U.S. satellite, shattered into 274 separate fragments.



V/STOL test

Research to develop practical V/STOL aircraft—ones that can take off and land either vertically or within very short distances—continues apace (see "Nutcracker V/STOL," PS, Sept. '76). The photo shows a large-scale model of a proposed new craft under test at the Ames Research Center in a cooperative venture of NASA and the Navy. The program's aim is the design, construction, and flight test of a V/STOL that uses a lift/cruise fan propulsion system. The model has three fans: one mounted in the forward section of the fuselage, where it would blast air downward to provide lift; and two fans mounted on top of the wing which would be used both for lift and in conventional cruise flight. PS

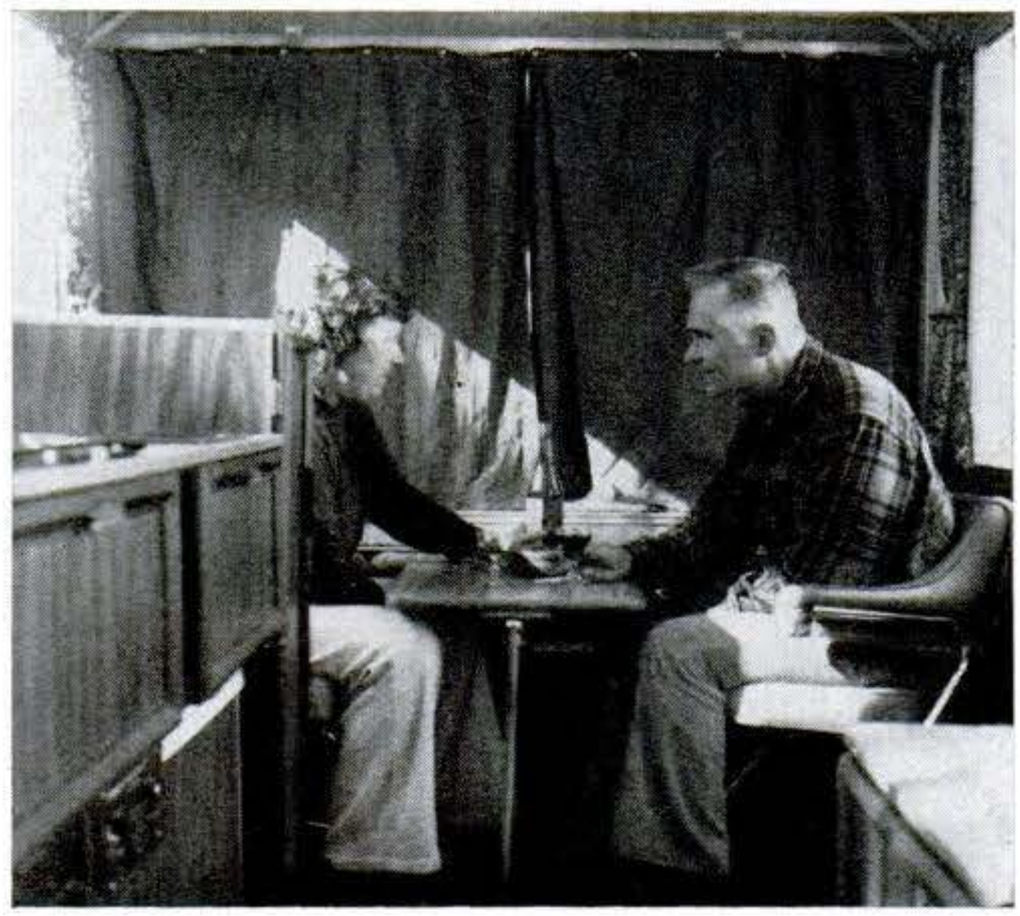
Low-profile **folding trailer**

If you like a pop-up's compactness on the road and in your driveway, but covet the luxuries of a medium-size travel trailer, take a look at Apache's new Cimarron.

We tested one for two weeks, figuring its insulated ABS top and solid ABS sides would keep us warmer than the canvas sides on our camping trailer.

Our midsize 350 V8 hardly noticed the 2400-lb. Apache—it's 16½ ft. long, 6⅔ ft. wide, 53 in. high when towed, has electric brakes. Cleverly designed, the Cimarron opens into a 24-footer that sleeps six. The heater (get the circulator type) kept us comfortable down to freezing outside. But carry two 20-lb. propane tanks in cold weather.

A basic Cimarron—range, sink, water tank, icebox, electric brakes, curtains—is $3220 f.o.b. Vesely Co., Lapeer, Mich. 48446. Add a thousand dollars for all the extras ours had.—*E. H. Arctander*



Apache Cimarron camper PS reporter tested was well-fitted, with: three-burner stove, exhaust fan, heater with circulator, refrigerator, air conditioner, sink, 20-gallon water tank, DC converter, two padded chairs (at left) for indoors or out, drapes, and more. Dinette table shown at left can also be set up outside. It took two adults about 20 minutes to get rig set up.

Aircommand 40-channel CB.

From the people who bring you Marantz—the world's finest stereo systems—comes the Aircommand CB-640—the finest in 40-channel CB. With Aircommand you get over 25 years experience in outstanding 2-way communications products.

Full 6 Watts of audio power. Provides plenty of punch so your speaker cuts through freeway noise.

Dual-conversion superheterodyne receiver with dual-cascaded ceramic filters. Together, both features provide the most complete rejection of unwanted signals, assuring you unsurpassed selectivity and sensitivity.

4 big Watts of RF power. Aircommand delivers the maximum power legally allowable to let you belt out the big sound.

100% modulation capability. Even when you talk softly into the mike, your message cuts through loud and clear, thanks to one of the most advanced mike preamp and compressor designs in CB today. With Aircommand, you don't have to spend an extra $30 to $40 on a "power mike." You can't buy better modulation than Aircommand.

Specially tailored frequency response.

LED 40-channel selection display. Easy-to-read, night or day.

8-LED (light emitting diode) meter display. Provides an easy-to-read display of SWR (standing wave ratio), modulation, and incoming or outgoing signal strength—instantly, accurately.

Special emergency Channel 9 scan with exclusive Aircommand "beep" alert. No matter what channel you're on, a special Aircommand CB-640 circuit continuously and silently monitors Emergency Channel 9. When someone starts transmitting on Channel 9, a unique "beep" alerts you, so you can tune yourself in and give assistance.

Public address capability. The versatile Aircommand CB-640 public address package lets you (1.) Talk into the CB mike and out an exterior public address speaker. (2.) Attach a tape recorder to the auxiliary jack on the

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"SAY, SMOKEY—"

A clinic on cars by Smokey Yunick, America's most famous mechanic

Spark-plug fouling

I have a 1972 Ford Maverick 200-cu.-in. six-cylinder. I have 25,000 miles on its overhauled engine (new pistons, rings, bearings, valve job). The head is milled 0.060 and I've installed 0.060-shorter pushrods to compensate. At 12,-000 miles the compression was 190 psi. At 20,000 miles it fouled the No. 3 plug and was getting 900 miles to a quart of oil. Now at 25,000 it gets 400 miles per quart. I inspected the valve seals, and all of them are intact and working. If I keep the No. 3 plug clean, it runs great. The No. 3 cylinder checked out at 110 pounds, and the rest at 180-plus on a compression tester. The plug color is medium tan. I have a replacement Holley one-barrel carb. What gives? I expect over 50,000 miles on a valve job.

Jim Luby, Lake Forest, Ill.

If you're correct in your observation of the valve seals being okay, the fouling and low compression on No. 3 cylinder and the high oil consumption indicate your basic problem is the piston, piston rings, or bore damage in No. 3 cylinder. It could also be a valve or a few other tricky problems. Get to a Sun cylinder-leakage tester, put No. 3 on T.D.C. with the valves closed, and I bet you'll find the problem. If it blows into the pan, it's the piston bore, or rings. If it blows through the carb, it's the intake valve. If it blows out the exhaust pipe, it's the exhaust valve. While you're at it, check the other five cylinders.

Leaded to unleaded?

I have a 1969 Toronado which requires premium fuel. Since one of the functions of leaded fuel is to lubricate valves, can the new unleaded gasoline be safely used? I tried a tankful and heard no audible knock.

J. P. Materi, Fort Lauderdale, Fla.

Don't do it. You won't hear anything—your problem isn't whether the fuel will pre-ignite. The real trouble is that engines built for leaded gasoline depend on lead to lubricate the exhaust valve and seat. Unleaded shortens the life of these valves. Newer engines have harder exhaust valves and seats to deal with lack of lead.

Oil query

I've just purchased a mini motor home powered by a 1976 GMC 400-cubic-inch engine. The owner's manual says to use a multigrade detergent oil. The local GMC service manager recommends a 30-weight nondetergent oil for break-in (until the engine stops using oil) and 30-weight detergent oil thereafter. He states that use of non-detergent oil allows the rings to seat, whereas detergent oil doesn't. What do you recommend?

Tom Draper, Abilene, Tex.

For new engine break-in, the factory oil GM puts in is as good as or better than anything you can get. I think you could reduce engine life if you changed the original oil before the recommended mileage. At that point I suggest going by what the owner's manual says.

Oil-change interval

I am in the process of buying a 1977 Maverick with a 250-cubic-inch engine. Literature on this vehicle indicates oil-

Continued

...You never heard it so good!!!

CB-640 rear panel, and boom your tape out through the same external speaker. (3.) Mix your voice from the CB microphone with the program material on the tape recorder. Both voice and tape sound at the same time through the external speaker. (4.) Beam your **received signal** through the external speaker.

Built-in standing wave ratio circuitry. Measures the efficiency of the antenna system for optimum performance.

Other outstanding features include: Delta fine tuning control, digital synthesizer with phase-locked loop, automatic noise limiting switch, noise blanking switch, squelch control, RF gain control.

Also available: Aircommand CB-140; Aircommand CB-340. All 3 units bring you state-of-art design, flawless craftsmanship and day-in, day-out reliability. Try them out now at your Superscope Aircommand dealer.

TM Aircommand by SUPERSCOPE.

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[*Continued*]

change intervals of 7500 miles and oil-filter-change intervals of 15,000 miles.

It has been my custom in the past to change the oil and oil filter at 2000-mile intervals, using a recognized brand of oil.

The dealer I'm buying the Maverick from offers a free oil change and replacement of oil filter every 3000 miles for the life of car ownership.

What should I do? Continue my past custom of 2000-mile intervals for oil changes, or go for the longer interval?

Irving D. Smith, Hopedale, Mass.

You've got a hell of a deal there if the dealer's oil is correct in type and weight. Take it—3000 miles is not too long to leave oil in. I do have my doubts about the additives in the oil lasting 7500 miles. At that change interval, your oil might still be clean, but the additives could already have been used up. Changing the oil too early, just because it's your custom, could be plain wasteful. After all, with today's oil shortage, we have to think twice before we throw any oil away.

Bypassing the converter

I have a 1976 Chevette. I would like to bypass the catalytic converter and use regular gas. Is it legal if I do it myself? What would I gain by this? Would the valves last longer? What about the gas filter and plugs? If the plugs need to be changed, what brand and range should I use?

Leonard O. Johnson, Englewood, Fla.

The only real gain would be that regular gas is cheaper than unleaded. You would save four to five cents a gallon.

Ethically, you shouldn't tamper with the emission controls, though it's probably not illegal if you do it yourself. No garage in your state can do it legally. If you can get regular gas in the car now (and you can't unless you rework the filler neck) the lead will destroy the catalyst, which will then work only as a muffler. Plugs, filters, and tune-up specs will remain basically the same.

My guess is that engine life would be about the same and valve life might be a little longer with leaded gas.

But I say don't do it. In time, with a little luck, maybe we'll get some engineers in Congress and get better answers to emission-control and economy questions. Most politicians are lawyers and their IQ regarding automotive engineering is around 32 below zero.

Interlock inconvenience

We have a terrible problem with our 1974 VW Super Beetle. Every time I sit in the right front seat and buckle the seat belt, my husband cannot start the car until I raise myself off the seat. Everywhere we go he says, "Okay, now raise it up." Then I do and the car starts.

I weigh only 140 pounds and he weighs about 200 pounds. We don't balance out! Could this be the problem? The car does seem lopsided. The buzzer keeps sounding until I get off the seat and we get the car started.

Ellen B. Ellingson, Valencia, Calif.

Fixing your ignition-buzzer problem won't cost much. Go to a good automotive electrician and get the buzzer and ignition interlock unhooked. They are a pain in the part you have to lift up. But use the belts; they are very important.

The case of the lopsided Beetle is not so easy, and really not fixable unless it's only driven with both of you in it. If it really bugs you, a free fix is possible. Place a 60-pound bag of sand right behind your seat.

The best pickups

What years and makes of pickup trucks are the sturdiest, both in the 4WD and conventional types? I'm mainly interested in the ones with ¾-ton rear axles, but am not too concerned about engines.

C. R. Howard, Caldwell, Idaho

I assume your choice is American ¾-ton only. That's Chevy, Ford, Dodge, and Jeep (GMC is a Chevy).

In all makes, 4WD is the toughest. My choice would be Chevy or Ford. Neither is super-rugged. I've been around oil fields quite a bit and it looks to me as though the Ford is the better of the two. Boy, they really give 'em hell out there. These days, pickup trucks have turned into cars with pickup boxes. The older pickups (pre-1960) were tough. Those old GMC's would wear out two '77's. Lots of us need a rugged pickup to work with. Hope somebody builds one soon.

A slight mistake

In the December issue you gave a reply to a question on unleaded fuel: "You'll find that unless you change your fuel-filter arrangement, you do not have a choice about what fuel you use."

We cannot figure what the fuel filter has to do with the kind of gas you use, or how the filter would affect the catalytic converter. We are anxiously awaiting your reply.

Ed Nolan, Gulfport, Miss.

Glad you wrote. I missed that in proofreading. My answer is wrong because of one letter. I meant to say "fuel filler," but it came out "filter." The unleaded fuel filler is so small that a regular or high-test nozzle can't get in and open the flap, so fuel will blow back at you. Thank you. PS

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—," Popular Science, 380 Madison Ave., New York 10017. Questions cannot be answered by mail.

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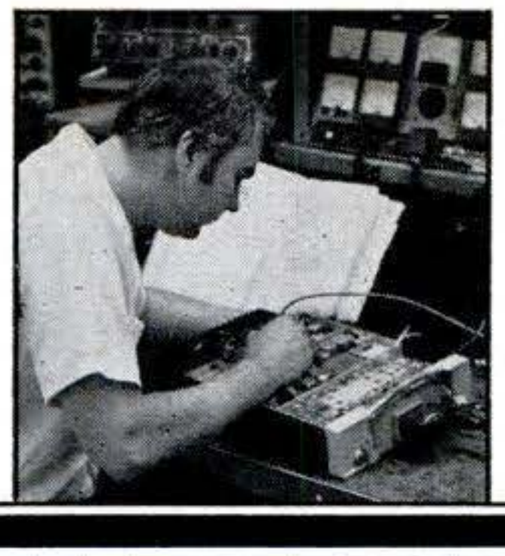

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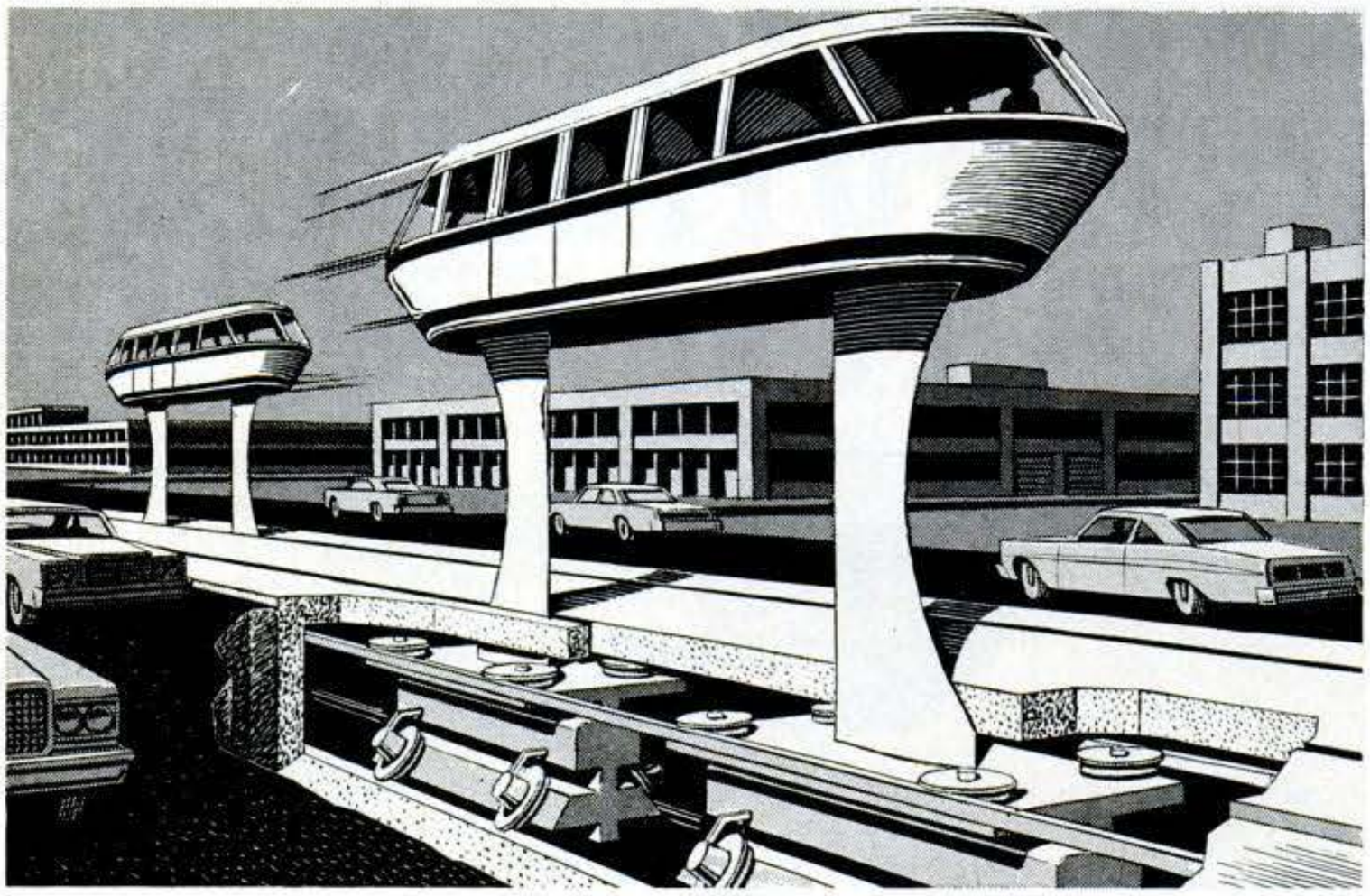
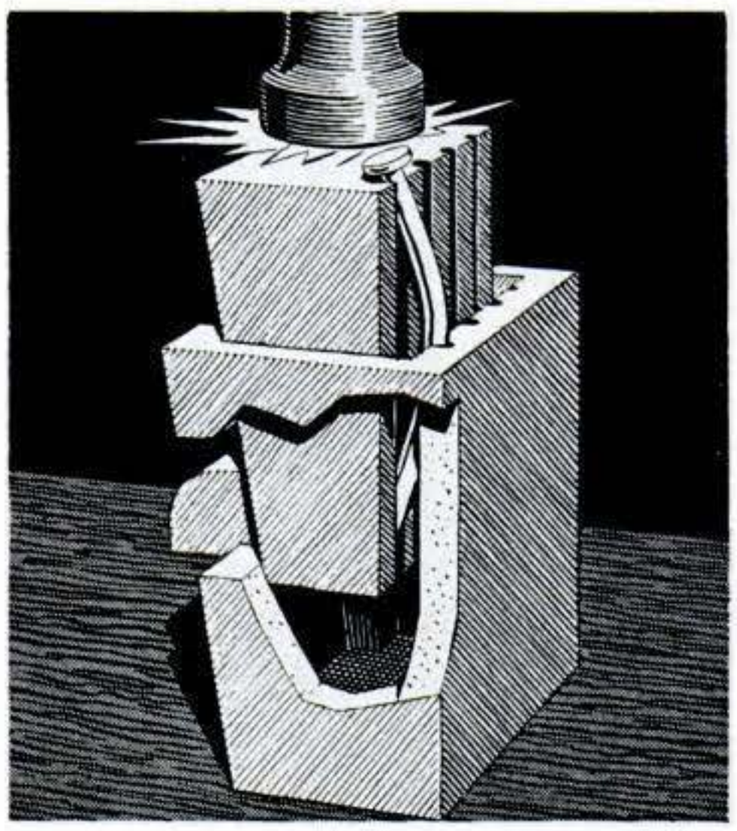
NEW IDEAS FROM THE INVENTORS

ILLUSTRATIONS BY RAY PIOCH



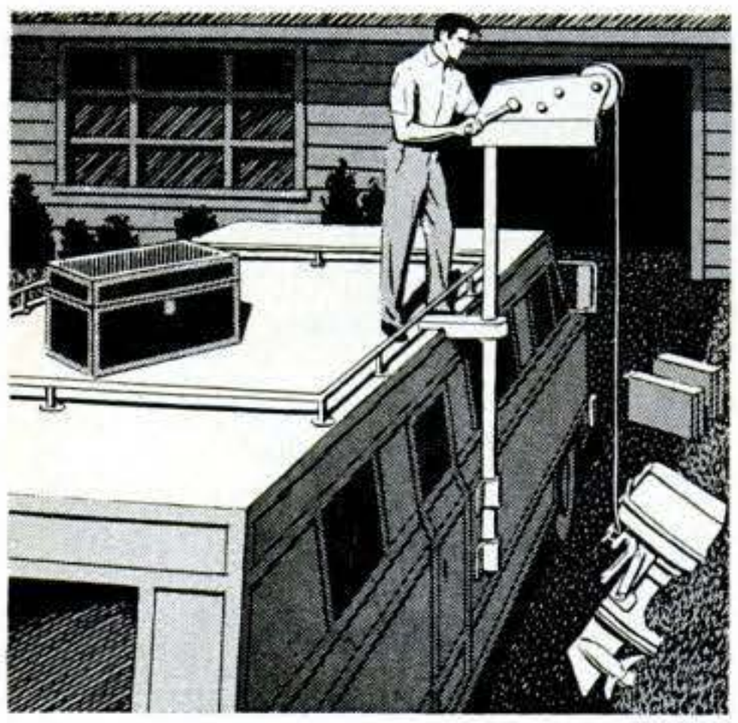
Mass-transit system rides highway median

Traffic flow in congested areas might be eased and speeded up by setting running gear for cable-car-type passenger or cargo carriers in trenches dug along existing medians or highway edges. Lift mechanisms would raise cars to clear roadway traffic, to switch or reverse them on elevated routes, or merge them onto connecting lines. Overhead winches, alternating with side or bottom rails, might reach down from moving struts to engage containerized cargo.



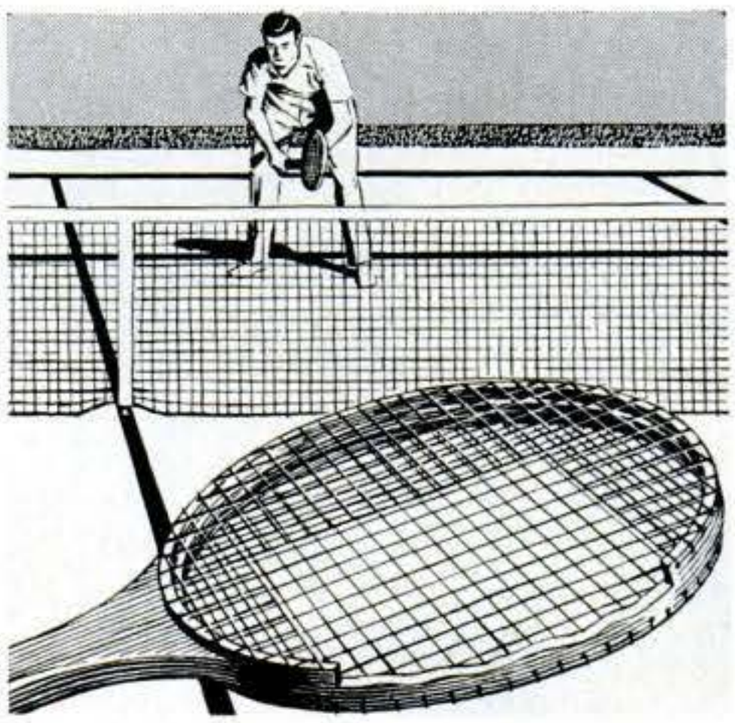
Grooved box straightens nails

With this grooved anvil and its matching, slightly tapered die in your workshop, you wouldn't likely be hung up on a job for want of one or two straight nails. Since bent nails are usually in ample supply, you'd just place one in a groove of the right size and hammer down the die to wedge and true the nail. To free the die—and nail—you'd tap a slotted lug.



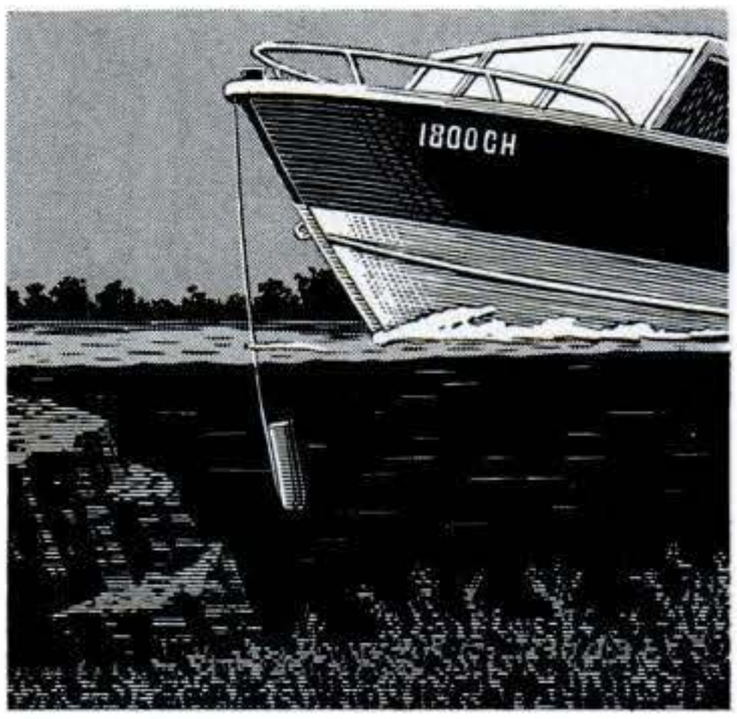
Hoist loads camper top

Slipped into brackets bolted to the side of a trailer or rec vehicle, this telescoping tube would let you set a hand-cranked winch at any convenient height above the roof line, then drop and raise a hook to load or unload heavy gear. Rotatable in its bracket, the removable hoist could be levered in, out, or sideways to grab or position cargo.



Dual racket improves backhand

Two independently strung faces on this tennis racket would let you adjust tension—and even string material—to give your forehand more control and your backhand more power. The two sides would be strung flush with the frame to reduce mishits "on the wood," increase effective playing area, give you a better chance to apply top spin or slice.



Drag switch spots shoals

Metallic rings in the top and bottom of this weighted, mercury-filled cylinder would close a shoal-warning circuit when the cylinder dragged or tipped in any direction. A third—straight—contact, extending from the suspension-cable electrode to the mercury pool, could be switched in from above to test the alarm circuit in shallow water.

The following patents have been issued on these inventions: **Transit system**—No. 3,859,925 to Billy J. Hartz, Seattle, Wash.; **Hoist**—No. 3,836,024 to Michael J. Mantino, Lake View, N.Y.; **Double racket**—No. 3,968,966 to Cesare A. D'Aquanni, Pleasant Valley, N.Y.; **Nail straightener**—No. 3,992,918 to David R. Broyles, Lawrence, Kans.; **Shoal-drag alarm circuit**—No. 3,859,490 to Gerald J. Fohey, Aurora, Colo.

Copies of patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

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15 mg. "tar," 1.0 mg. nicotine, av. per cigarette, FTC Report Dec. '76

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DETROIT REPORT

By JIM DUNNE

Chrysler's look-alike

Chrysler's new subcompact, scheduled for introduction next year, looks much like the Simca 1307. It's no coincidence, as Chrysler also builds the Simca in France. The 1307 was a hit in Europe, and the company thinks it can repeat that success by building a similar car here. Styling themes shared by the cars include a fastback roofline, six-window side styling, blacked-out grille, and rectangular single headlights. Special styling touches for the U.S. car include a forward-slanting grille much like that on the Volvo, and protruding bumpers—made of aluminum—that meet U.S. protection standards.

Diesel will spread

Volkswagen's diesel engine, scheduled for debut in the Rabbit this spring, will be offered on the Dasher in 1978. That's the first move. Eventually, you might see the engine in other VW cars, especially the Audi Fox, even though its performance will be marginal for U.S. roadways. The diesel is much slower than the gasoline engine in the Rabbit. Zero-to-60-mph times are 17-seconds plus, compared to under 12 seconds for the gas engine. VW is promoting high economy—52 mpg in the EPA highway test—and simplicity of emissions system as selling points for the diesel. Because a diesel engine runs clean, it needs no air-cleansing complications like a converter, air pump, or exhaust-gas-recirculation system.

V6's can be smooth

Buick, the leading maker of V6 engines, will offer three versions of the engine in its 1978 model lineup. A new offering will be a smaller-displacement version of the 231 V6 currently available. Displacement will be slightly under 200 cu. in., probably about 196. It will be offered as the fuel-economy leader. A high-powered version of the 231 will have a turbocharger system that will increase output by 50 percent, maintain the fuel economy of the standard 231, and out-accelerate some V8's. Another big change will be made inside the engines to smooth out the inherently unbalanced V6 spark-plug firing order. By offsetting crankpin journals by 30 degrees, the Buick will fire a cylinder every 120 degrees of crankshaft rotation, thus providing the same smoothness at idle as a V8 engine.

Fours are out

At least that will be the case in Buick and Oldsmobile intermediates for 1978. The new Cutlasses and Centurys will depend on the V6 engine as their fuel-economy leader. GM will not attempt to put four-cylinder engines in those cars. The 1978 intermediate line will be smaller and lighter in weight than the present GM compacts, so it is logical to assume that they are prime candidates for the high-economy four-cylinder engines built by Chevy and Pontiac. But Olds and Buick turned thumbs down on the idea. One result: You'll see an enormous increase in the number of V6 engines in the 1978 GM lineup.

GM has no big surprises

The 1978 intermediates from GM will have all-new styling, but generally there will be few surprises. The biggest differences among the models are their roof shapes, which are divided between fastback and notchback. Cutlass and Century sedans will have a smooth, fastback profile, while Chevelle, LeMans, Grand Prix, Monte Carlo, Cutlass Supreme, and Regal will be notchbacks. Those tiny opera windows are out. Instead, conventional rear-quarter windows will be offered in the coupes, while the four-door models will have six-window side styling.

All models will feature chrome steel bumpers and separate grilles, though some specialty versions of the coupes will have integrated bumper-and-grille assemblies made from plastic. V6 engines will predominate. The in-line six used in intermediates reportedly will not fit under the foreshortened hoods of the new cars, so they won't be available. Buick and Chevrolet will supply the V6's to Oldsmobile and Pontiac.

Metal seats are a target

For a long time GM has been trying to come up with a plastic seat to replace the metal one used on all its car lines. Next year, we will see an important achievement of that effort. The Corvette will be equipped with a plastic seat of a new type. It has a formed shell and reinforcing parts made of plastic that are lighter in weight and simpler to build. Covering this shell are foam cushions topped with plastic upholstery. The seat will be billed as the first plastic bucket seat in the industry, and the forerunner of similar designs that will be offered in other sporty cars from GM.

The tail end

Station-wagon tailgates are still under study at General Motors, even though GM has tried various designs in recent years. It looked as though GM had finally given up in its search for the ideal gate when the three-way tailgate was adopted for the B-body cars this year, after years of experimentation with clamshell and hatch-type doors. But next year the GM intermediates will have an old-fashioned split tailgate. The glass upper part is hinged from the roof and swings upward; the metal lower part is hinged at the bottom and swings downward. The reason: The design is lighter than the three-way gate. PS

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People write to PENNZOIL

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Mower Maintenance. I own a 3.5 hp push type lawn mower which has been performing well up until this year. Lately it's been running hot and using several ounces of oil each running hour. Can you recommend steps I can take to alleviate these problems?

K.A.B., Berkeley Heights, N.J.

We suggest that you perform the following maintenance on your lawn mower:

1) *Install new spark plug. Be sure that the gap is correctly set.*
2) *Clean air filter. If it is a metal type, rinse in kerosene. If it is a sponge type, clean with soap and water and then saturate with a few drops of oil.*
3) *Check your exhaust ports for carbon deposits. If present, they can be removed by scraping with a wooden dowel.*
4) *Check to make certain fuel line is free of obstructions, and clean gasoline tank if needed.*

Good luck with your new maintenance program!

Storage Steps. I am considering storing my 1976 Harley-Davidson for a while (maybe even as long as 20 years). Do you recommend that the engine be completely disassembled?

A.G., Nashville, Tenn.

For long term storage of possibly twenty years, you should disassemble your entire engine and pack the parts after coating them with oil. Your transmission should be treated in a like manner. The parts should be stored in a heated, dry environment and checked periodically for signs of rusting and corrosion. For short term storage of one or two years, we recommend that fresh oil be put in both the crankcase (if 4-cycle) and transmission. In addition, remove the spark plugs, squirt ½ ounce of oil in the cylinders, turn over by hand to distribute the oil and then replace spark plugs but do not tighten securely. Again, store your bike in a heated, dry environment.

Under Water. I am presently using Pennzoil #705 Multi-Purpose Lubricant to grease the chassis of my vehicles. Can I also use 705 lube on the wheel bearings of my boat trailer? The wheels are sometimes submerged in water.

R.D.H., Baker, Oregon

Pennzoil Multi-Purpose Lubricant #705 can definitely be used in your boat trailer wheel bearings. We have had excellent reports on its use in this application. We do suggest that the bearings be lubricated frequently and particularly after they have been submerged in water. This will force any residual water out of the bearings and keep them lubricated.

Racing Oil Query. I recently bought a 1971 Opel GT with 30,000 miles, and wanted to know which Pennzoil single weight oil I should use. I keep the revs up since I do a lot of around town driving, and because of the engine's small displacement (1.9 litre). Is there any advantage in using Pennzoil Racing Oil in my Opel over one of your other motor oils?

L.D., San Gabriel, CA

For your Opel GT, we recommend a single grade oil–either Pennzoil Z-7 SAE 30 or Pennzoil Racing Oil SAE 30. Each contains the same type and amount of detergent additive, but the Racing Oil contains additional extreme pressure and anti-wear additives along with more foam suppresant. Since you keep your engine revved up, the Racing Oil would be preferable for maximum protection.

Pennzoil Happy. I have recently switched to Pennzoil because of the trust many of my friends have in your fine product. I have been using another oil for the past few years and I have noticed that my cars were using too much oil. My oil consumption has finally stabilized, thanks to Pennzoil Motor Oils.

J.B.P., Tuscumbia, Ala.

We are happy to hear that you have switched to Pennzoil and are enjoying such good results.

Oil Change. I have always had my car engine flushed before changing my oil. Recently a mechanic suggested that I first drain the oil, fill the crankcase with kerosene, and then run the car for about five minutes. Do you agree with this oil-changing method?

A.J., Port Jefferson Station, N.J.

We do not recommend that an engine flush be used at each oil change. Running your engine for even a short period of time with kerosene can be detrimental. Instead, change your oil and filter according to the recommended intervals in your owner's manual. A high quality oil such as Pennzoil Multi-Vis or single grade with Z-7 contains detergents and dispersants which will keep your engine clean.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell *us* a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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Compact wagons
–roomy and versatile

Aspen and Pacer are at opposite ends of the compact-wagon spectrum in many respects. Aspen carries six passengers, Pacer four. Aspen has four doors, Pacer has two. Aspen is longer than a Nova, Pacer is shorter than a Vega.

PS ratings—test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars, and that other seemingly identical cars may vary in performance. Also, weather conditions (noted in our spec table) vary from test period to test period. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Aspen	Pacer
Fuel economy	2	2
Acceleration	5	4
Braking	2	2
Handling	1	2
Maneuverability	2	2
Ride comfort	4	3
Quietness	1	1
Roominess	4	3
Visibility	5	5
Entry/exit ease	5	4

By JIM DUNNE and RICH CEPPOS

The Dodge Aspen SE and AMC Pacer D/L are the first of a new breed of American station wagons. They are designed to combine the load-carrying capacity of midsize wagons with the fuel economy of compacts, while giving up nothing in the way of passenger comfort to their larger stablemates. Pacer and Aspen (and Aspen's twin, Plymouth Volare) will be joined by other small wagons, to be introduced in the next six months. Ford will introduce wagon versions of its Fairmont and Zephyr lines for

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Scout conveniently gives you maximum cargo length by simply folding up the rear seat. But for maximum cargo length in a Blazer, you have to unbolt and leave your rear seat behind.

Yes, I'm interested in more detailed information on Scout's design specs and off-road features. Please send me the brochures I've checked below. Enclosed is 50¢ for postage and handling. **705LBPS**

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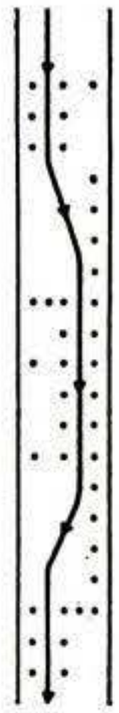
EPA fuel mileage (mpg)

	Aspen	Pacer
Highway	20	24
(California)	16	21
City	15	17
(California)	11	15

Both cars are equipped with catalytic converters, air injection, and exhaust-gas recirculation.

Pacer experiences early rear-wheel lock-up in the PS brake test.



PS accident-avoidance maneuver is a high-speed lane change that simulates swerving around an obstacle when there is no time or space to brake. The Aspen, shown here, understeered (wanted to plow straight ahead), with much body roll. The Pacer understeered less, but was only marginally quicker. Both cars were easy to control up to their limits, which is as important as ultimate cornering power in emergency situations.

the 1978 model year, and GM is planning similar models for the downsized '78 intermediates: Chevelle, LeMans, Cutlass, and Century.

The Pacer and Aspen both fall into the compact class and are the most luxurious models in their respective lines. But they are worlds apart in how they attempt to provide maximum interior room and comfort in a compact package.

The Aspen looks and feels like a scaled-down version of the big, do-it-all family workhorse wagon popular in the 1960's. If you can accept its average fuel economy, it really has no serious shortcomings. Chrysler engineers designed this car to look and feel much larger than it really is. The ride has the soft, secure feel that you associate with big cars. It is very well controlled, and soaks up both tar strips and bumps without undue up-and-down body movement. The big-car feel is apparent in handling too, as the Aspen responds to steering inputs with a hint of the sluggishness you find in big wagons.

The Aspen's low belt line and the low position of its instrument panel result in excellent all-around visibility—among the best you will find on a domestic car. Forward visibility is also excellent, despite the comparatively level, long hood line. The low-positioned instrument panel is especially important in forming an impression of the car. You get the feeling of sitting high up, better able to observe the traffic and control the car.

The Aspen's split-bench front seat features individual reclining seat backs for both driver and passenger, a fold-down center armrest, and handsome cloth-and-vinyl covering. If you're six feet tall or over, you'll have no trouble getting comfortable here. The rear seat also is very roomy for a compact, and the station-wagon roof line leaves plenty of head room for rear-seat passengers. A big plus is the well-cushioned rear seat—it's as comfortable as the one in the Aspen sedan. There's even enough room in back for six-footers, even with the front seat pushed all the way back.

A single push button at the center-top of the rear seat releases the seat back to swing forward and fold flat. It's easy to reach and simple to operate. Carpeting on the floor of the load area runs eight inches up side panels to form an effective protective covering.

The Pacer's styling and features are quite different from the Aspen's, but it comes close to matching the Dodge in a number of ways.

Some of what the Pacer loses in overall length—it's actually two feet shorter than the Aspen—it makes up in width, where it's more than four inches wider. Because the Pacer's rear seat is located between the rear wheel wells, it's more than 14 inches narrower than the Aspen's. So it's only wide enough for two, while three can sit fairly comfortably in the back of the Aspen. Leg room in the Pacer, however, is ample even for tall persons. The Pacer's two-door styling makes rear-seat entry and exit more difficult than in the Aspen, even though the passenger-side door is four inches wider than the

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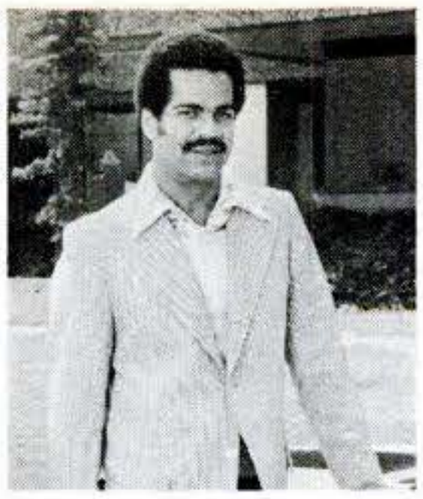
"I feel we can rely upon Firestone. They're fine. I don't even know they're there. And that's the kind of tires I like."

Carol Zweifel,
Police Officer



"I selected Firestones and I'm very happy with them. Do yourself a favor. If you've got to drive, drive on Firestones."

Hausmann DePass,
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Cliff Williamson,
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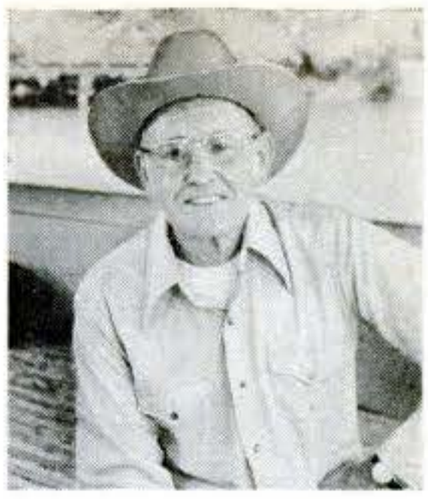
"We have steel belted radial tires. Firestones. Based on what we've just experienced, I would buy Firestone again."

Ruth Metcalf,
Director of Christian Education



"I would recommend Firestone tires to anyone. A young fellow that works for me is going to put a set on. He told me if they don't last he's going to make me pay for them. I told him 'okay'."

Virgil Guess,
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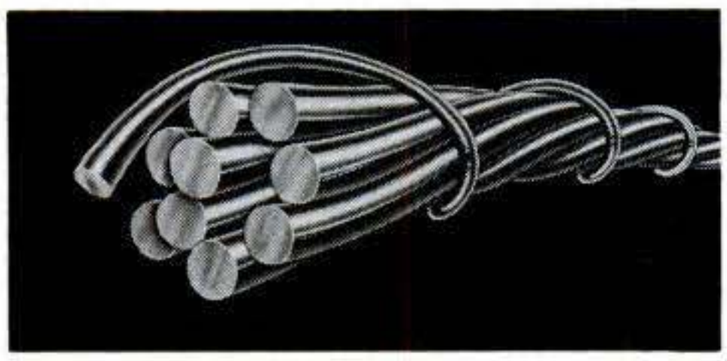
5 million test miles now bring you the experienced radial.

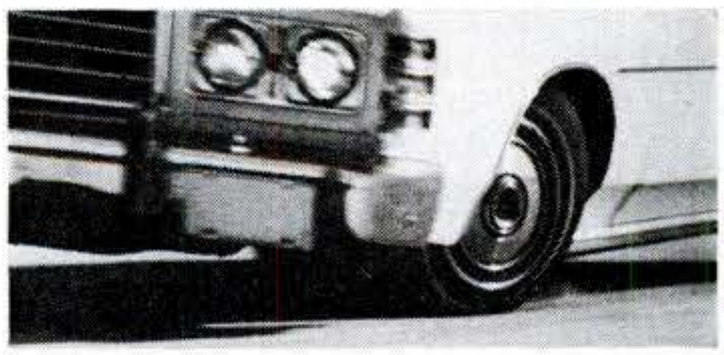
At the Firestone Developmental Proving Ground at Fort Stockton, Texas, Firestone endlessly works at improving its steel belted radials. And it is here that the new Firestone 721 has become what it is. The *experienced* radial.



Our new 721 steel cord. Much stronger and why.

Before we tell you some of the things we do at Fort Stockton, we thought you'd like to know at least a few of the ways that our Radial 721 has become our finest steel belted radial tire as a result of torture testing.

Our tire gets its name from a steel cord we put together a different way than we ever did before, with each cord wound in a seven-strand-plus-two-strand-plus-one-strand method. In addition to the *way* it's wound, we now use ten strands of steel per cord where five were before. The result is a stronger cord for tire durability.



Be glad you're not a tire.

The life of a Firestone tire is not very pleasant at Fort Stockton, Texas. We do things in our development testing you'll probably never do in a lifetime of driving, and we urge you never to try.

We drive cars at 90 miles an hour day after day until a tire fails.

We corner on different surfaces, as fast and furiously as a driver can, plow cars through a road of water, overload station wagons with heavy sandbags, even *purposely* create blowouts by running tires over knives.

The part of a tire you never look at, we do.

But development testing isn't worth anything unless you use the results. At Firestone we not only torture a tire like our new Steel Belted Radial 721, we analyze the effects on every part of its anatomy. The tread, the sidewall, the belts, the beads.

Torture makes for peace of mind.

How can you have more peace of mind and take advantage of what we learn at Fort Stockton? By remembering that the safety of any tire depends on a lot of factors—on wear, load, inflation and driving conditions.

Our peace of mind comes from knowing we've done and are constantly doing our part, torturing tires in every important way we can think of to make them work hard and long and well for you.

Ask a friend about Firestone

...and ask your dealer about the new Firestone Steel Belted Radial 721™.

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Folding the Aspen's rear seat was a snap. Push a single button centrally located in the top of the backrest—the seat is released, and swings forward.

Serviceability ratings

How easy is it to service our test cars? For example, is that heater hose clamp out in the open where it can be reached easily? To give you an approximation of how difficult it is for a typical person to perform various service operations on the cars, we examine each vehicle. Here's what the numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty, no worse or better than most other cars; 4, easy; 5, very easy.

	Aspen	Pacer
Checking fluid levels:		
Battery	5	5
Master cylinder	5	5
Windshield washer	5	5
Engine oil	5	3
Coolant	5	5
Checking engine:		
Spark plugs	5	2
Distributor	3	2
Carb adjustment	3	3
Oil filter	4	3
Oil fill	4	4
Replacing hoses:		
Top radiator hose	5	5
Lower radiator hose	5	4
Heater hoses	5	4
Changing bulbs:		
Headlights	5	5
Taillights	5	2
Front running lights	5	5
Front parking lights	5	5
Front directionals	5	5
Rear directionals	5	2
Rear running lights	5	2
Checking fuses	5	5
Spare-tire accessibility	5	5
Changing belts	5	3

driver's. Pacer's visibility is unmatched, especially to the front, over the low, stubby hood. Room for the front-seat passengers is exceptional. The interior is quieter than the Aspen's, and the ride is just about Aspen's equal in smoothness. Pacer also has a nimbler feel, and responds more readily to steering changes than does the Aspen.

We found the rear-seat release mechanism comparatively difficult to operate. You have to release catches on both sides of the seat to fold the back of the seat forward. Especially noteworthy is Pacer's instrument panel. It looks as if it belongs on a full-size luxury car instead of a compact wagon, and makes the Aspen's handsome dash appear mundane by comparison.

A big reason for Aspen's popularity is its optional 318-cu.-in. V8—a quiet and smooth power plant that delivers acceptable fuel economy. According to EPA mileage figures, the 318 Aspen delivers 15 mpg in city driving and 20 on the highway. (By comparison, the full-size Caprice wagon gets 16 mpg/city.) Aspen offers a 225-cu.-in. slant six as standard equipment, but it delivers only 16 mpg/city, 21 mpg/highway. Pacer's fuel economy is better—17 mpg in the city and 24 on the highway—about what you'd expect from a six-cylinder-powered car of 3400 pounds. If you're looking for all-out fuel economy, you'll have to go to the subcompact wagons. But if you will accept moderate economy to gain more ride comfort and carrying capacity, Aspen and Pacer fill the bill well.

It is heartening to note the improved performance of the Pacer wagon over the Pacer sedan we tested earlier [PS, July '75]. The new two-bbl.-carburetor version of AMC's 258 cut 0-60 acceleration times by nearly six seconds—to 15.2 seconds—and effectively takes the Pacer out of the geriatric class. Fuel economy as measured by the EPA figures is about the same with the new engine as with the one-bbl. version that it replaces.

Braking performance for both cars was disappointing. The problem was rear-wheel lockup, which caused the rear end to slew to one side during panic braking. To keep the cars from going broadside in the braking lane, the brakes had to be modulated (pumped) vigorously, and a lot of steering corrections had to be made. The cause? Improper front/rear brake bias. Station-wagon brakes are calibrated for full load conditions. So rear wheels, which carry more load in a wagon than in a sedan, are designed to

Continued

Pacer's cargo capacity suffers because of its short length. Its cargo room can't match the Aspen's, but it should be adequate, as Pacer is only a four-seater. Both cars had flat cargo floors, which made sliding in cargo easy.

Performance comparison with selected 1974, 1975, 1976, and 1977 models

	1977 Chevrolet Caprice V8	1977 Ford LTD Landau V8	1977 Plymouth Gran Fury V8	1977 Olds Cutlass V8	1976 Buick Skylark V6	1976 Ford Granada Inline 6	1975 Bobcat Wagon V6	1975 Astre Wagon Inline 4	1974 Mercury Colony Park V8	1974 Pontiac Grand Safari V8
Mpg (city driving)	16.0	11.0	12.0	15.2	18.0	12.0	15.5	18.6	11.4	11.1
Accel. 0-60 mph (sec.)	13.5	13.9	15.2	12.3	16.6	22.7	17.2	19.7	12.5	12.3
Brakes 60-0 mph (ft.)	142	168	143	180	138	135	123	157	147	200
Handling (mph)	60.0	51.3	49.9	60.0	60.0	58.2	58.2	56.3	49.9	56.3
Maneuverability (mph)	28.6	22.4	24.6	25.0	26.0	26.8	26.0	26.4	21.8	23.9
Noise @ 60 mph (dBA)	63	64	65	65	68	65	69	72	64	67

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I can't taste numbers. I can taste Winston Lights.

I was looking for a cigarette with low tar. But the low tar cigarettes I tried had no taste. Now I smoke Winston Lights. I get the low tar I want. But more important, Winston Lights are all taste. Winston Lights are for real.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

13 mg. "tar", 0.9 mg. nicotine av. per cigarette, FTC Report DEC. '76.

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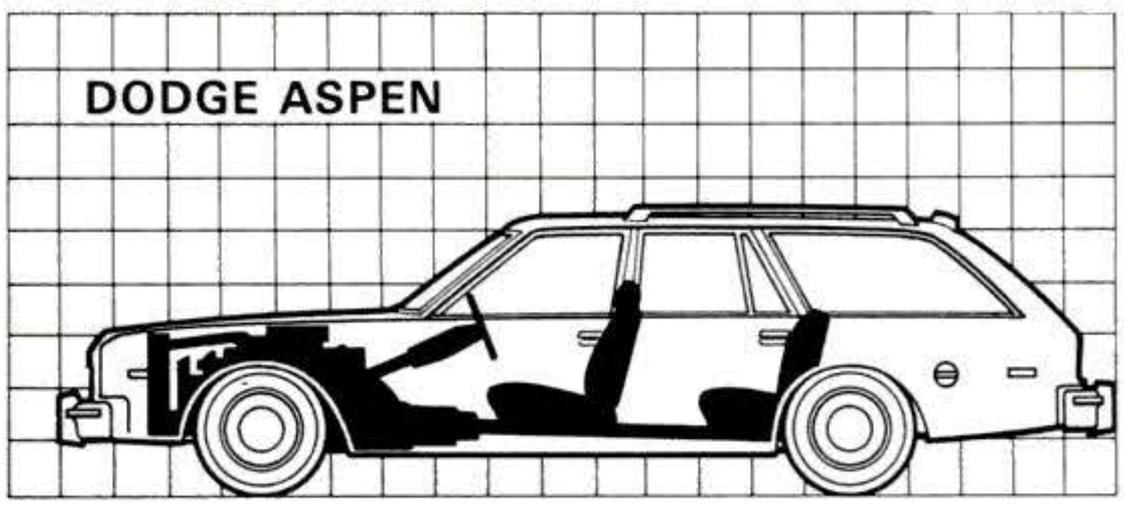

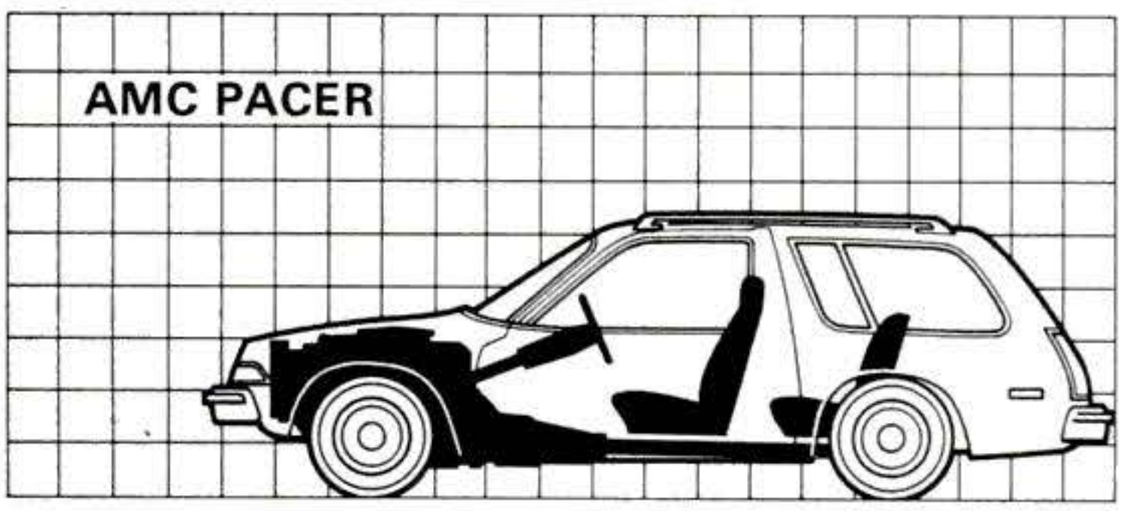

Aspen is laid out like any conventional wagon, but the Pacer isn't. To get adequate leg room for rear-seat occupants, the Pacer's rear seat had to be placed between the rear-wheel housings, effectively making it more than a foot narrower than the Aspen's.

exert greater braking force than in a sedan. Thus, when wagons are running empty, the rear brakes are over-assisted and tend to lock the wheels before full force can be applied at the front. The lockup condition occurred whether the brakes were cool or hot.

In the handling tests, the cars acted more like traditional wagons than at any other time. In the accident-avoidance maneuver, the Aspen SE understeered (plowed straight ahead) at its limit (53 mph). The Pacer was more neutral, and slightly faster (56.3 mph) through the course, probably a function of its lighter weight and wider stance. In the low-speed maneuverability test, neither car distinguished itself. The cars did not exhibit exemplary handling, but they can be trusted not to surprise you in an emergency situation.

We were disappointed with the noise levels we recorded for each car. Subjectively, the interior noise seemed quite low, but the test instruments heard differently. The problem here may lie in the wagon body. The open rear compartment picks up noises from the rear axle and tailgate that do not occur in sedans, and this may be the reason for the relatively high noise levels.

How good are the Aspen and Pacer as wagons? They're both good—though not equal in cargo capacity. The Aspen offers 73.4 cubic feet of cargo space with the rear seat down. The load floor is flat for its full length from the hatch door to the back of the front seat, which makes loading bulky items easy. The spare tire is stowed neatly underneath the rear floor. The only problem is that the floor level is relatively high off the ground — 24½ inches — and this makes lifting heavy items a chore.

The Pacer's rear seat folds down to form a 62-inch-long cargo bed. It has the same high liftover problem as the Aspen but offers less useable space—47.8 cubic feet—because of its shorter length. Its spare tire is also located beneath the rear floor.

It's easy to see why Aspen has become America's number-one-selling wagon. It offers all of the traditional virtues of big wagons: a large cargo area; a smooth, quiet ride; a high level of interior appointments; and a block-long list of options. It gives up little in the way of interior room to intermediates, yet is compact in exterior dimensions. And it does all this at a price far below that of full-size wagons. It's a design that's been well thought-out and well executed, and the American car-buying public has realized this.

The poor sales performance of the Pacer wagon is harder to understand. It is smaller inside than the Aspen/Volare, yet no less comfortable. Its performance, ride, handling, and appointments almost equal the Aspen's; its fuel economy is better—and its base price is almost $700 less than the Aspen's.

Maybe the public still believes that AMC's far-out fishbowl-on-wheels is too frivolous a design to incorporate traditional values. If that's how the public views the Pacer wagon, it's making a mistake. PS

Aspen and Pacer—specs, dimensions, and test results

	DODGE Aspen SE	AMC Pacer D/L
DIMENSIONS (inches)		
Ground clearance	7.1	6.9
Front leg room (max.)	42.5	40.7
Front head room	39.2	38.5
Front hip room	57.2	55.8
Rear head room	38.7	38.4
Rear leg room (min.)	36.6	34.9
Rear hip room	57.0	42.2
Couple distance	33.8	30.0
Min. knee room	1.2	−0.26
Wheelbase	112.7	100.0
Overall height	55.2	53.2
Overall width	72.8	77.0
Overall length	201.1	174.0
Front track	60.0	61.5
Rear track	58.5	60.0
SPECIFICATIONS		
Engine type	V8	In-line 6
Displacement (cu. in./cc)	318/5200	258/4230
Compression ratio	8.5:1	8.05:1
Carburetion	2 bbl.	2 bbl.
Net hp @ rpm	145 @ 4000	108 @ 3600
Net torque @ rpm	245 @ 1600	194 @ 2000
Transmission	3-speed automatic	3-speed automatic
Axle ratio	2.7:1	3.08:1
Tire make	Goodyear	Goodyear
Tire type	Polyglas II Radial	Polysteel Radial
Tire size	FR 78x14	DR 78x14
Steering	Power; recirculating ball	Power; rack and pinion
Overall steering ratio	18.7:1	20.8:1
Turns lock to lock	3.5	3.75
Turn diameter (ft.)	40.7	37.0
Front suspension	Independent, non-parallel arms w/ transverse torsion bars	Independent twin ball joint, coil spring, and lower arm
Rear suspension	Parallel, longitudinal, semi-elliptical leaf springs	Hotchkiss, leaf-type springs
Front stabilizer-bar diameter (in.)	1.0	0.94
Rear stabilizer-bar diameter (in.)	None	None
Brakes	Power-assisted disk/drum	Power-assisted disk/drum
Brake swept area (sq. in.)	355.3	310.6
Fuel tank (gal.)	20	21
Cargo space (cu. ft.) (rear seat folded)	73.4	47.8
Liftover height (in.)	22.8	20.8
Curb weight (lb.)	3866	3437
F/R weight distribution (%)	54/46	53/47
Trailer-towing capacity (lb.)		
Tongue weight	200	250
Gross weight	2000	2000
Basic price	$4488	$3799
Price as tested	$5600	$5107
TEST RESULTS		
Acceleration 0-60 mph (sec.)	14.6	15.2
Acceleration 0-80 mph (sec.)	28.7	28.05
Acceleration 25-70 mph (sec.)	17.25	18.3
Brake test (cool) 60-0 mph		
Stopping distance (ft.)	145	180
Pedal pressure (lb.)	70	100
Efficiency (% of 1 g)	100	97
Disk temperature (°F)	140	127
Brake test (hot) 60-0 mph		
Stopping distance (ft.)	178	174
Pedal pressure (lb.)	110	105
Efficiency (% of 1 g)	100	100
Disk temperature (°F)	560	644
Handling test (mph)	53	56.3
Maneuverability (mph)	23.9	24.6
Interior noise @ 60 mph (dBA)	70	69

TEST CONDITIONS: Ambient temperature 30°F; relative humidity 50 percent; barometric pressure 31 inches

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"I always wanted to be a police officer. I think it's a chance to help people, and do something beneficial. I enlisted in the Army as an MP because it's a step in that direction. Military police work isn't exactly like its civilian counterpart – which is mainly concerned with law breaking and crime solving. Here, a great deal of our job is security and peace-keeping assignments. But I believe the demands of both jobs are the same. You've got to be committed, and professional. It's hard to be a policeman, from what I understand. This will help."

SP4 Joseph Ockwig, 8th Infantry Division, Bad Kreuznach, Germany

Join the people who've joined the Army.

LOOK AND LISTEN

By JOHN FREE

Beta-format VCR's

This fall, Zenith Radio Corp. plans to market video-cassette-recorder decks and deck/TV consoles that use the remarkable new Beta-format technology. Developed by Sony, Sanyo, and Toshiba in Japan, Beta format captures two hours of material on one-hour, pocket-size Betamax cassettes [PS, Dec. '75].

Zenith's decision, as the leading U.S. color-set maker, is a major push for home VCR's. Beta-format decks will initially be made by Sony to Zenith specifications. Prices will be competitive with other high-quality machines, says Zenith. The three Japanese Beta-format developers will undoubtedly offer similar decks here, too. Other large U.S. consumer electronics firms may also market made-in-Japan decks, perhaps with a different tape format.

Beta format employs special circuitry and achieves a phenomenal storage density for TV by halving the track width and speed of the already highly compact Betamax cassette. Thus a $16 Betamax cassette, which holds one hour of recording and playback with present machines, will record two hours in Beta-format decks. (A switch on Beta-format decks could permit playback of one-hour Betamax tapes—the limit of compatibility.)

Other continuous-play two-hour machines [PS, April, p. 46] are Quasar's $995 VR-1000 deck, using $34 cassettes, and Sanyo's $1290 model 8200, with $20 cassettes and a skip-field recording technique.

Meanwhile, Sony has announced that Betamax and future Beta-format deck owners can have home-movie films and slides transferred to Betamax cassettes. For about $25, S/T Videocassette Duplicating Corp. (Leonia, N.J.), the first of several depots, will transfer three to four reels of film to tape.

Later this year, S/T will use an electronic black box developed by Sony to correct color-shifted (aged) film before transfer. A series of old films and slides I saw at a press conference, tinted almost monochromatic red because of dye changes, were shown corrected on Betamax cassettes. The corrected color was an amazing improvement. Color restoration, scratch elimination, titles, or an added sound track boost transfer prices.

Noise filters

Recently I tried two noise-reduction devices, one new, the other updated. The newest add-on component electronically eliminates most audible pops and clicks (impulse noise) that ruins record listening. The updated component sharply reduces the steady background hiss present on tape, discs, and broadcasts.

The $200 model 5000 impulse-noise-reduction system (upper unit, below) from Scientific Audio Electronics has circuitry that can distinguish pops and clicks from music. SAE's circuit recognizes the fast attack and slow decay times of impulse noise, plus its out-of-phase character. Such impulse noise shuts off the 5000's circuitry for a split second, eliminating the interference. Program material prior to the impulse fills in the brief audio gap. Want to find out how effectively it works? A switch on the unit, used to set a sensitivity control, lets you listen only to the noise being filtered out.

I found that the 5000 eliminates most but not all impulse noise; it makes an otherwise unlistenable disc quite acceptable. The unit plugs into tape-monitor jacks.

Another tape-monitor add-on is the 1201A dynamic noise filter from Burwen Research (lower unit, below). The electronic filter is a redesigned and repackaged version of the 1201 [L&L, May '75]. The price has jumped $100, to $400. The maker, formerly Burwen Laboratories, was out of business briefly, and is now a subsidiary of KLH.

The 1201A reduces noise five to 12 dB from tapes, records, or FM broad-

Continued

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Coleman makes $ense

Coleman Recreational Vehicle Products
Wichita, Kansas 67201

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Get the number one name in RV Air Conditioning, plus a FREE chill chasing electric heater! This 5,600 BTU heater is built right into the interior ceiling plate. Just a flick of the dial allows you to select heating or cooling to match the weather outside.

It's ideal for those mornings & evenings that are just cool enough to make you uncomfortable, but not cold enough to fire-up your LP furnace.

Only your participating Coleman dealer can make this fantastic offer right now! And Coleman quality air conditioners deliver unequaled efficiency, with super-quiet performance to give you cool, quiet comfort. Compare! Exclusive Dial-A-Comfort control lets you "fine-tune" your own personal comfort setting. All this plus a FREE built-in heater that takes the chill off without wasting precious LP gas. This limited-time offer is good on Deluxe ("A" Model) air conditioners purchased between April 1, 1977 and June 30, 1977 from participating RV dealers.

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2ND PRIZE... 10 Fourteen-foot Hobie Cat® Catamaran Sail Boats!

3RD PRIZE... 25 Coleman Family Size Oasis® Tents!

4TH PRIZE... 50 Fifteen-foot Coleman Canoes!

5TH PRIZE... 100 Peak 1™ 4-man Lightweight Tents!

6TH PRIZE... 400 Coleman 12-volt Inflate-Alls™!

7TH PRIZE... 2,500 Coleman Roundabout® Cooler Jugs!

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WITH THE 1977
Jamboree

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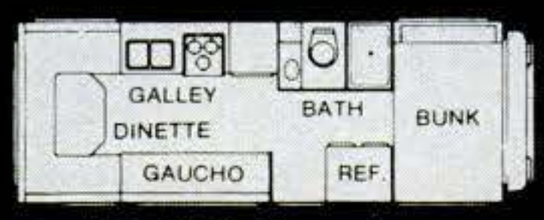
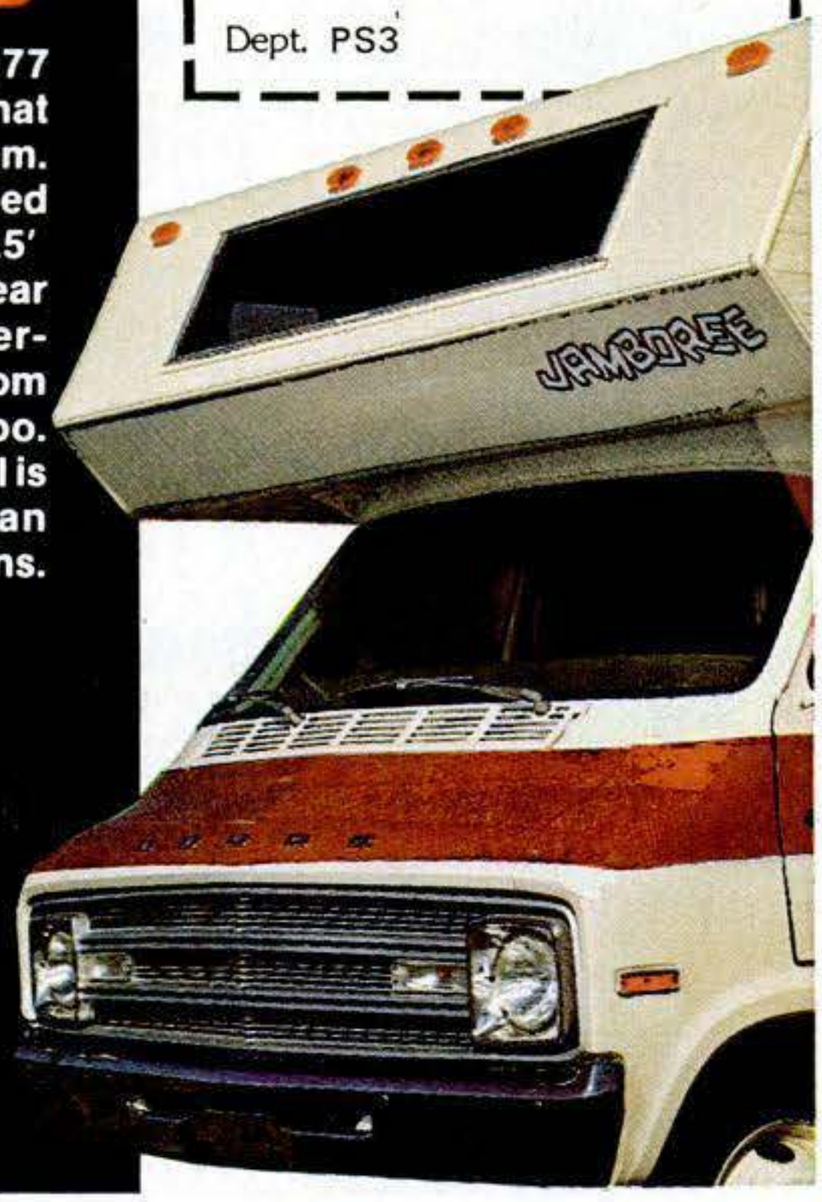
Dept. PS3

Part of the fun of owning a 1977 Jamboree is picking the plan that fits your needs. Jamboree has 'em. Choose from five family planned models in lengths from 20' to 22.5' including rear and side bath, rear dining and even a special entertainment model. Choose from three interior color schemes, too. The all-purpose 17' Jamboree II is also available for couples. Plan ahead for great family vacations. Jamboree has the plan.



Model G-22.5'. Sleeps five.



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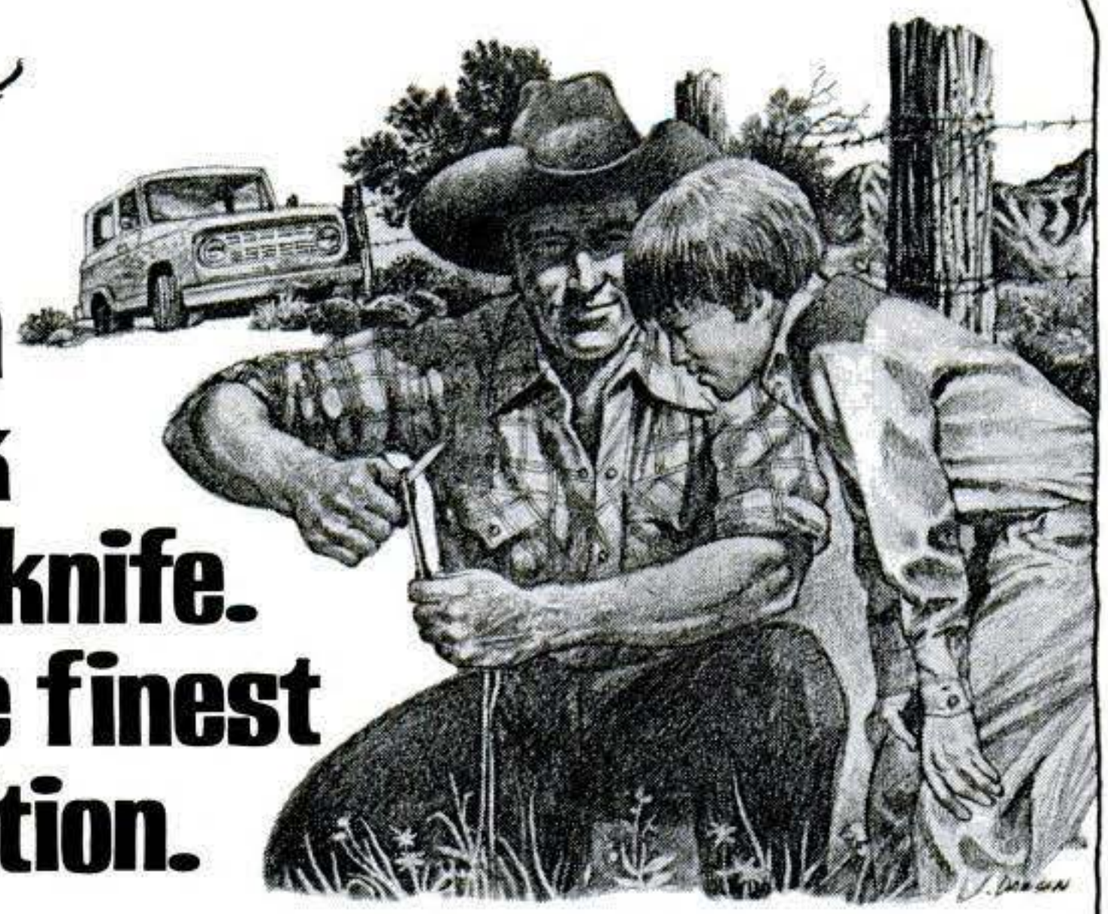
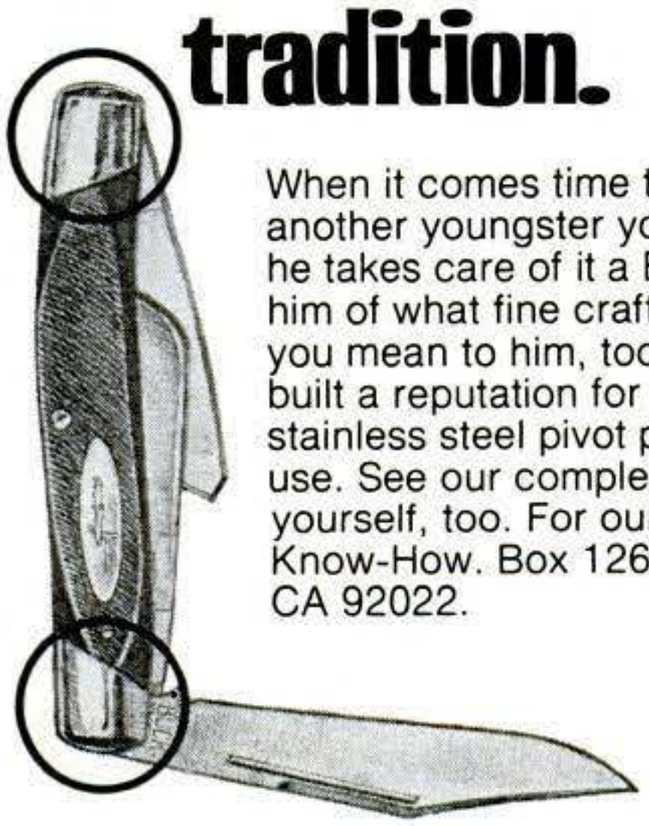


Give him a Buck pocket knife. It's in the finest tradition.



When it comes time to buy a knife for your son, grandson or another youngster you care about, give him the very best. If he takes care of it a Buck pocket knife will be around to remind him of what fine craftsmanship means all his life. And what you mean to him, too. High-carbon Buck steel blades have built a reputation for edge-holding quality. And the tough stainless steel pivot pins will hold up through years of hard use. See our complete line at your dealer. Pick one up for yourself, too. For our free booklet mail a postcard to Knife Know-How. Box 1267, El Cajon, CA 92022.

BUCK KNIVES
famous for holding an edge

Look and listen

[*Continued*]

casts by attenuating high and low frequencies when little or no music is present. The dynamic filter or "gate" opens fully during loud passages, which mask background noise. The abrupt reduction of background hiss, I've found, can easily mislead you into thinking musical high frequencies have been diminished. Actually, when the 1201A is adjusted properly, the sound is unaffected, and red and green front-panel LED's blink on and off to the music.

For severe background noise, the 1201A sensitivity control must be lowered, sacrificing high frequencies. Impulse noise can trigger the "gate" open, also letting a burst of background noise through. However, feeding the output of SAE's 5000 into the 1201A minimizes this false triggering. SAE recommends such pairings. Another possibility: Phase Linear's model 1000, which is a combination noise-reduction, dynamic-range-expansion unit.

What's needed now is the reduction of these and other highly effective new audio circuits to microcircuitry, so they can be inexpensively built into preamps and receivers.

Digitalized audio

At the winter Consumer Electronics Show in Chicago I spotted a welcome addition to the audio scene: a 22-pound, 150-watts-per-channel, class-D stereo amplifier from Sony. Class-D circuitry converts input signals to computer-like on/off pulses. Processing such signals produces little heat, so Sony's new amp needs minimal heat-sink area and is very compact. Sony also uses its new vertical field-effect transistors (V-FET's) in the amp. The class-D and V-FET combination produces beautiful sound. For $1000, it better. Another firm, Infinity Systems, also makes a high-end class-D amp [L&L, May '74].

At the June CES, Sony may unveil another application of digital electronics to the audio field. Already shown in Japan, Sony's adapter for its Betamax VCR's converts the video decks into ultra-high-quality audio tape recorders. The Betamax adapter uses pulse code modulation (PCM), a digital encoding technique used in telecommunications. Result: noiseless tape recordings with a dynamic range (difference between high and low signals) exceeding even that of professional machines.

Quick looks

- General Electric plans to market color TV's with infrared remote control. The use of infrared light instead of ultrasonic sound for beaming commands to a receiver would eliminate false triggering from jingling keys and such.
- RCA will put off regional marketing of its SelectaVision video-disc system [PS, Feb.] until 1978. Discs shown thus far play 30 minutes on each side. RCA has now developed a disc with 60 minutes' playing time on each side. PS

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ADVENTURES IN ALTERNATE ENERGY

A monthly sampling of projects PS readers have devised to conserve or replace fossil fuels

O.W. Wood: Solar + woodstove heats his water

By EDWARD MORAN

Last winter, as temperatures sank below zero in New Jersey, O. W. Wood sauntered down to his basement, calmly turned a valve, and threw some wood into a potbelly stove. Before long, hot water began flowing into his cubical storage tank —water that had been heated by both solar and wood.

Two years ago, Wood combined these two alternate sources of energy into a neat and compact package that has cut his family's oil consumption by nearly 30 percent. Blueprints and further data are available directly from the inventor (see address at end of this article).

System components

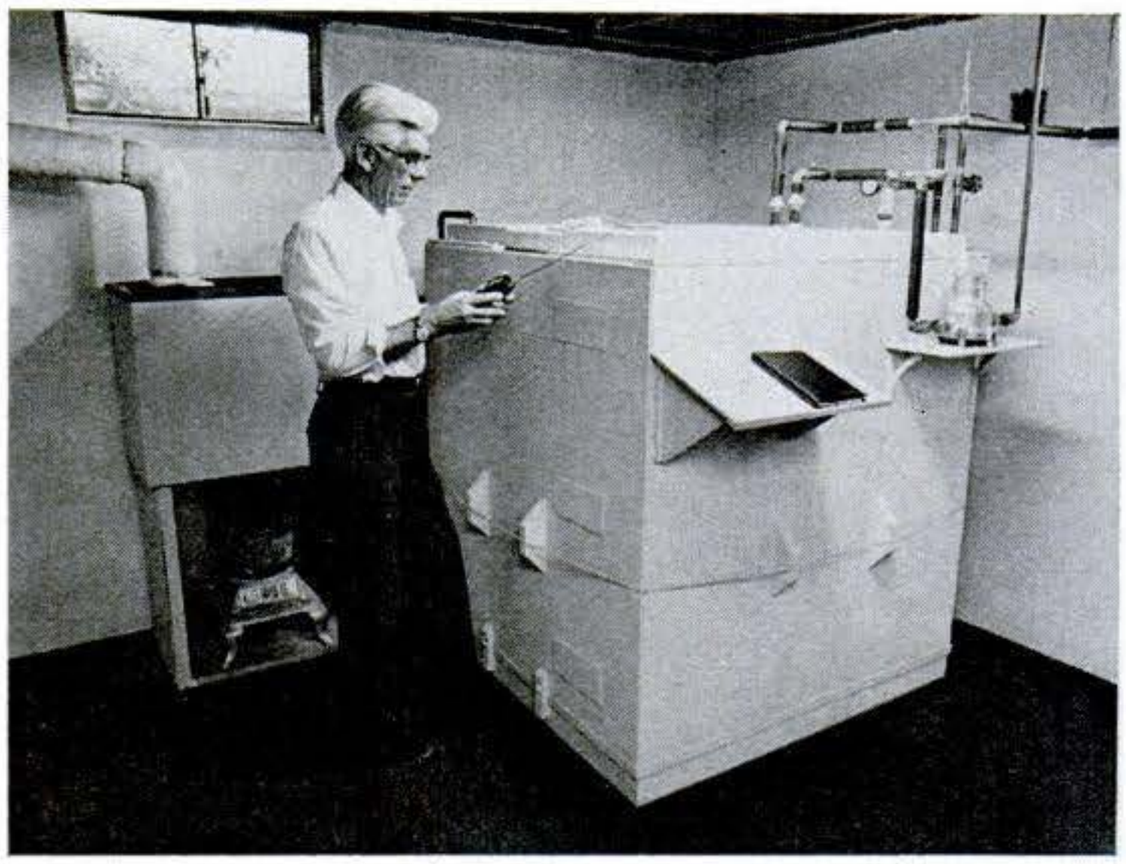
The Wood package consists of a ground-mounted solar collector and a stove and storage tank that take up only 30 square feet in the basement (see photos). "All of the hot water required by three adults runs through the system," says Wood. On the average, the solar system heats 10,000 pounds (1200 gal.) of water each month—formerly heated by an oil-fired space-heating furnace.

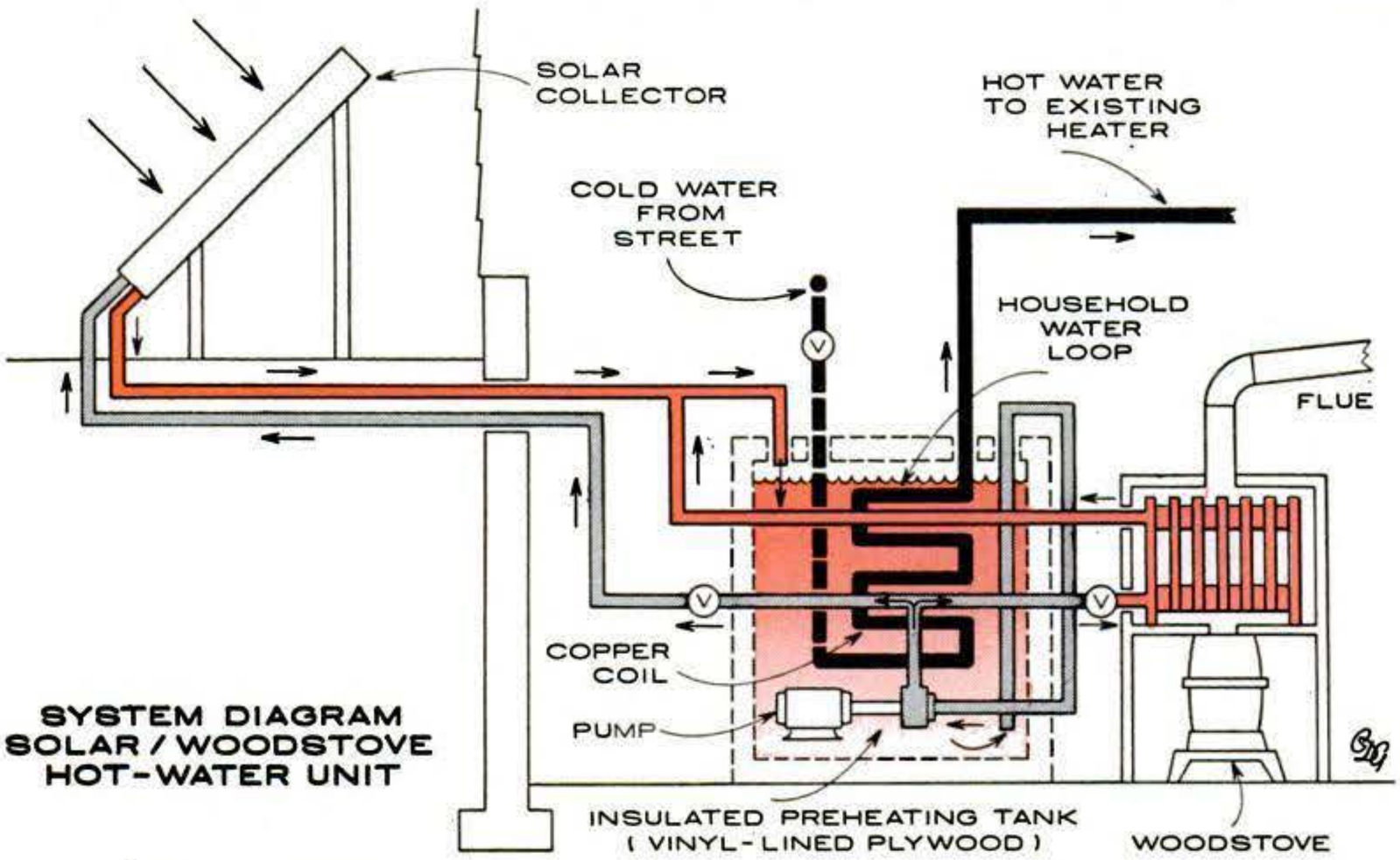
The wood "booster" is especially useful when the solar unit is unable to supply hot water on its own—on cloudy days or during the coldest season (November through February). "In these months," Wood tells me, "as little as 15 pounds of wood meets the needs of 2½ days."

Low-budget collector

Wood says his 32-sq.-ft. collector gives him about 100 Btuh per square foot. Highly efficient manufactured collectors can do better, but not at $5 per square foot, which is how much Wood spent on materials. And the collector is mounted at ground level, which eliminates the need for costly—and heat-losing—piping runs.

The collector is designed to drain





SYSTEM DIAGRAM SOLAR / WOODSTOVE HOT-WATER UNIT

Dual water-heating system combines solar collection with wood backup. In photo at left, vinyl-glazed collector is mounted at ground level to avoid problem of inappropriate roof pitch. Maintenance is simplified, too. In photo at right, inventor Wood checks storage tank; at his left is potbelly stove capped with radiator (enclosed in fiberglass-lined galvanized-iron box). Two-inch-thick Styrofoam insulation is pressed into place between all tank risers. Heated stove water and heated collector water merge outside tank and enter tank via pipe through lid. This permits air to enter collector and assist drain-down when required. Valves can be manually adjusted to shut off woodstove loop on warm, sunny days. Backup heater might still be required, depending on climate and demand for household water.

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down when the sun isn't shining, but the system can be adapted to permit use of antifreeze solution. (Note the closed domestic-water loop in the diagram.)

The frame is of plywood, edged with pine, to which inch-thick Styrofoam has been spot-glued. Four 60-ft. coils of ⅜″ o.d. copper tubing are required for the collector; they're installed at a slight pitch so water will drain down easily. The eight-foot run to the basement storage tank is ⅝″ garden hose wrapped in fiberglass and vinyl.

Wood recommends assembling the collector with glue, C clamps, and screws instead of nails. To enhance heat absorption, he covered the entire surface with cement (two 80-lb. bags of Sakrete should do the job, he says), and painted it flat black.

"Glass is excellent [as a covering]," Wood believes, "but expensive." Instead, he uses a sheet of clear vinyl five-mil thick. To prevent the cover from sagging in the sun, he glued some wood spacers to the cement surface.

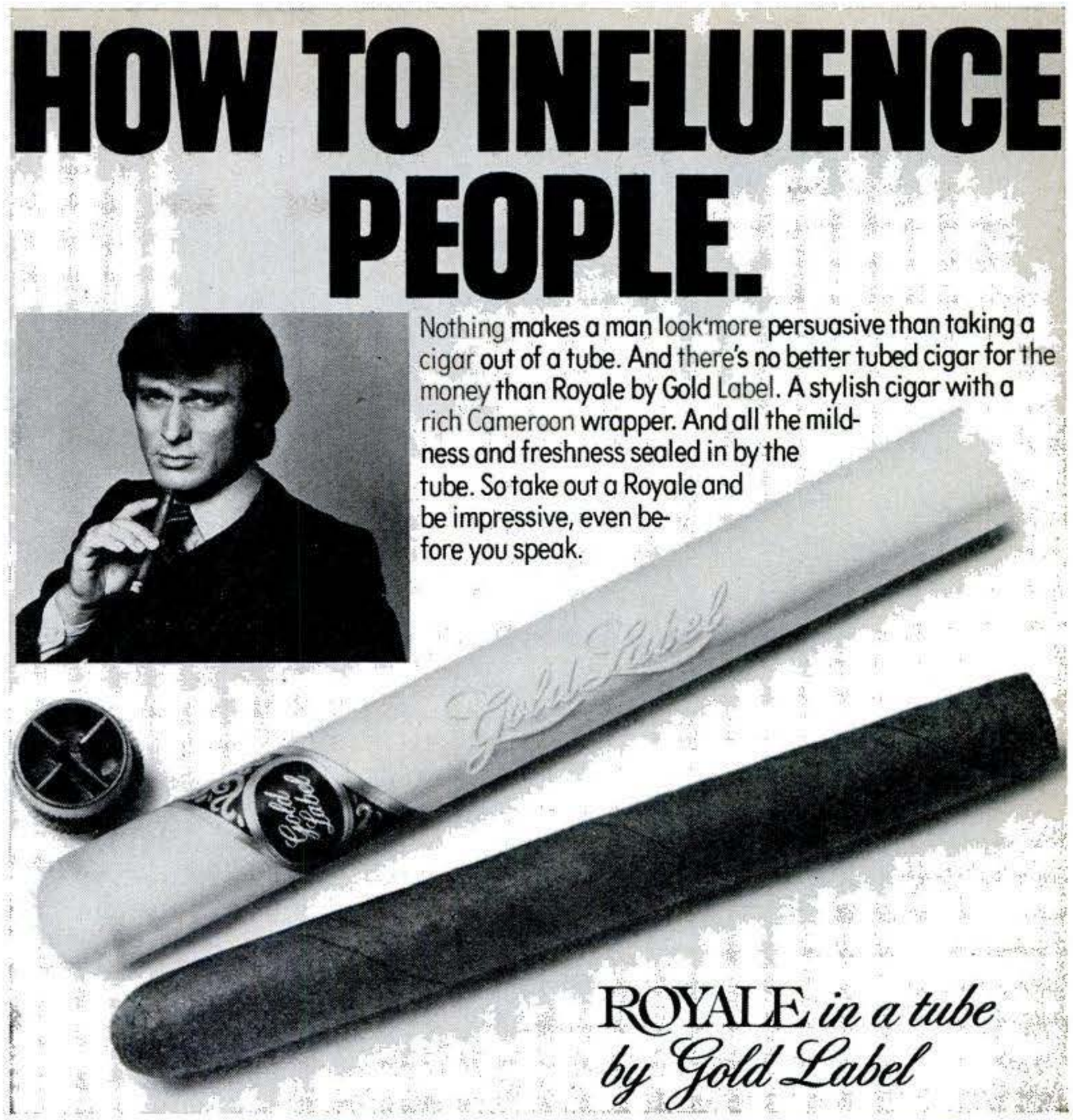
Storage tank

Wood's vinyl-lined plywood tank holds 3000 pounds (about 350 gal.) of water when full. Heated water from solar collector and wood stove enters through the lid (see diagram). Heat is transferred to the domestic loop via a copper heat-exchange coil suspended in the tank. Because of the considerable water pressure on all sides, Wood recommends using plenty of wood screws in construction. And the vinyl inner lining must be completely waterproof. (A swimming-pool technician might be able to handle this part of the job.) Finally, a pump was installed to draw from the bottom (coldest) section of the tank. Total cost for tank construction was $312. Used copper piping would have reduced this expenditure, claims Wood.

Wood-burning booster

A potbelly stove with a cast-iron radiator mounted on top completes O. W. Wood's heating system. (A water-jacketed stove would work too, he claims.) For safety, Wood first pressure-tested the radiator, and installed ½″ fiberglass insulation on the radiator enclosure.

To order plans, send $25 in check or money order to O. W. Wood, 82 Church St., Liberty Corner, N.J. 07938. To ask a specific question (free), enclose a stamped, self-addressed envelope. PS



Anything else is mock turtle.

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String trimmers

–fast, safe way to control weeds

Whipping right up to a stump's edge, the Toro Trimmer chops down high grass. The job might destroy a blade, but won't harm trimmer's nylon line.

Pick the right-size trimmer for the job you've got to do—and watch the weeds fly

By A. J. HAND

Any tool that can turn the tedious job of trimming your lawn into fun is bound to become a big seller. Throw in the ability to work where other tools can't, add tremendous safety—and you can see why string trimmers are among the hottest items in today's yard-care market.

Instead of sharp metal blades, string trimmers—or Weed Eaters as they are called, after the original

Continued

PS buyer's guide to string trimmers

Maker	Model	Appx. power	Gas or elec.	Weight (lb.)	Appx. cut diam.	Suggested price	Comments
Advanced Engine Products, Inc.	Estate 400	1 hp	G	8½	13"	$170	Trigger-fed line
	Landscaper 600	1¼ hp	G	9	14"	200	Trigger-fed line
Allegretti & Co.	Rota-Shear 1	6 amp	E	8	16"	70	3-wire
	Rota-Shear 2	1.3 amp	E	2½	7"	30	3-wire
Black & Decker Mfg. Co.	8205	1 amp	E	2½	6"	30	Double-insulated
	8209	4.3 amp	E	6	12"	60	Automatic line feed, double-insulated
Deere & Co.	John Deere Electric Weed Eater	4 amp	E	8	16"	70	Double-insulated
	John Deere Gasoline Weed Eater	3 hp	G	24	20"	290	Four cutting lines
Garden Pro Inc.	Spintrim JT103	3.8 amp	E	4½	N/A	30	Most power per dollar; cord lock; 3-wire
	Spintrim ST203	3.8 amp	E	4¾	N/A	50	Cord caddy and lock; 3-wire
	Spintrim ST303	5 amp	E	6	N/A	70	Cord caddy and lock; 3-wire
	Spintrim ST304V2	5 amp	E	6	N/A	80	Cord caddy and lock; two cutting lines; clip-on line replacement; 3-wire
	Spintrim SST403	1 hp	G	9¼	N/A	225	Two cutting lines; tie-on line replacement
Hoffco, Inc.	Whizz Witch	3½ hp	G	24	20"	290	Takes brush cutter blades, too
K & S Ind. Inc.	600	1.8 amp	E	3	11"	30	3-wire
	1002	2.7 amp	E	5½	13"	50	3-wire
	200	4 amp	E	6	13"	60	3-wire
	5000	1½ hp	G	10	16"	180	Two cutting lines
McGraw-Edison Co.	Village Blacksmith Graswip	1.5 amp	E	2½	6"	30	Hook-on line replacement; double-insulated
Sears, Roebuck & Co.	Grass Wacker	1 amp	E	3	7½"	30	Double-insulated
	Weed Wacker 7976	1.3 amp	E	2½	9½"	40	Double-insulated
	Weed Wacker 7779	4 amp	E	8	16"	69	Double-insulated
Stihl Inc.	FS150	1¼ hp	G	17½	N/A	330	Both take a variety of cutters; chainsaw
	FS200AV	1½ hp	G	22½	N/A	450	conversion kits available
Sunbeam Corp.	Trim Champ	4 amp	E	8	12"	70	Double-insulated
Toro Co.	Toro Trimmer Standard	3.8 amp	E	4¾	N/A	50	Cord caddy and lock; 3-wire
	Toro Trimmer Heavy Duty	5 amp	E	6	12"	70	Cord caddy and lock; 3-wire
True Temper Corp.	Cordless Weed Whip	N/A	E	8.5	7"	50	Rechargeable battery power; 40-minute running time
Weed Eater Inc.	Clippie	1.5 amp	E	2	8"	30	Double-insulated
	Snippy	2 amp	E	4½	10"	50	Double-insulated
	Needie	4 amp	E	8	16"	70	Double-insulated
	Super Needie	6 amp	E	8	16"	90	Double-insulated
	Weedy	3 hp	G	25	20"	290	Four cutting lines
	Weed	3 hp	G	18	20"	280	Two cutting lines
	Mini Weedy	1 hp	G	12	16"	230	

Advanced Engine Products, Inc., 7525 Mitchell Road, Eden Prairie, MN 55343; **Allegretti & Co.**, 9200 Mason Avenue, Chatsworth, CA 91311; **Black & Decker Manufacturing Co.**, Towson, MD 21204; **Deere & Co.**, John Deere Road, Moline, IL 61265; **Garden Pro Inc.**, 2655 Villa Creek Drive, Dallas, TX 75234; **Hoffco, Inc.**, 358 Northwest F., Richmond, IN 47374; **K & S Industries Inc.**, Box 612, Ft. Worth, TX 76101; **McGraw-Edison Co.**, Portable Appliance and Tool Group, 1801 North Stadium Boulevard, Columbia, MO 65201; **Sears, Roebuck & Co.**, Sears Tower, Chicago, IL 60684; **Stihl Inc.**, 5701 Thurston Avenue, Box 5514, Virginia Beach, VA 23455; **Sunbeam Corporation**, 900 Jorrie Boulevard, Oak Brook, IL 60521; **Toro Co.**, 8111 Lyndale Avenue South, Minneapolis, MN 55420; **True Temper Corporation**, 1623 Euclid Avenue, Cleveland, OH 44115; **Weed Eater Inc.**, Box 42334, Houston, TX 77042.

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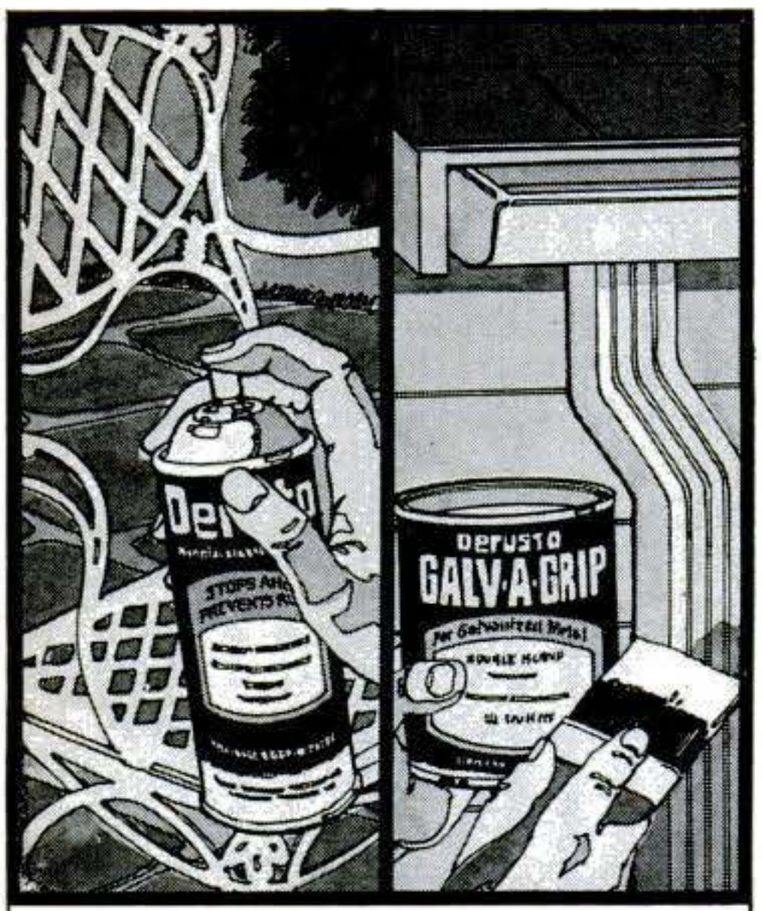

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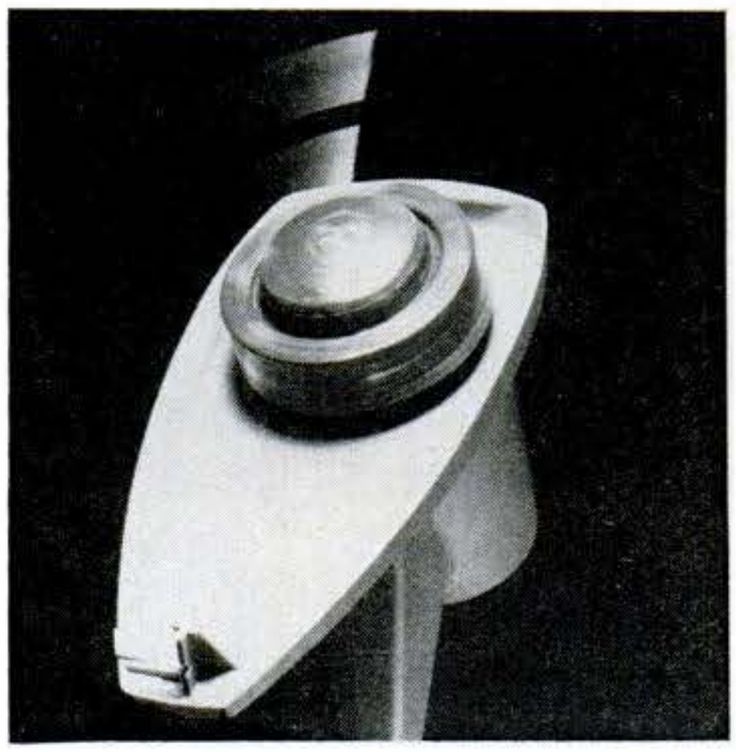
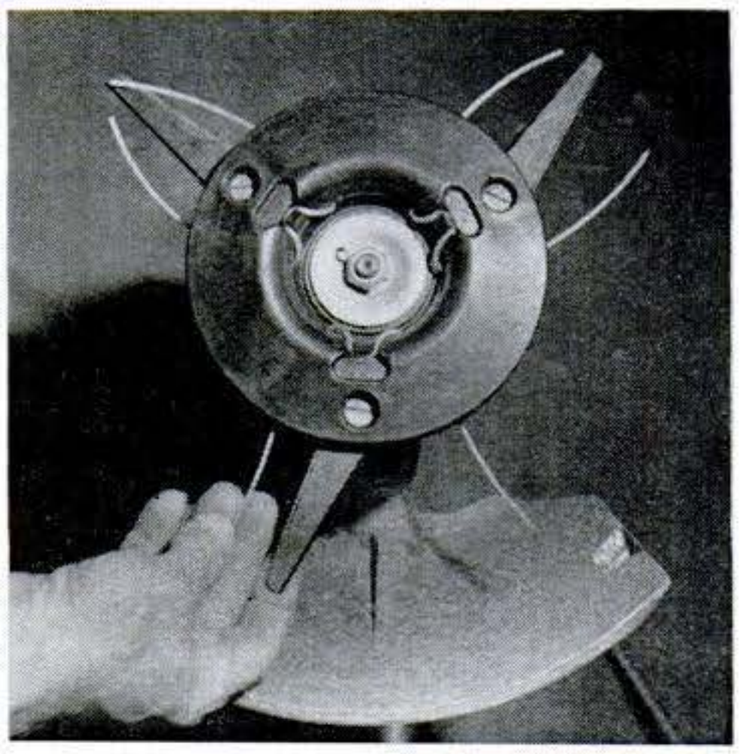
String trimmers

[*Continued*]



Spinning so fast it looks blurred, the nylon whip on Sears Weed Wacker can lick toughest weeds. Spool holds line.



Stihl's versatile head chops with lines, swinging plastic knives, or both. It fits Stihl brush cutters, some chainsaws.

brand—use a length of heavy nylon monofilament to whip weeds and grass into submission. The nylon is attached to a fast-spinning shaft. This exerts a strong centrifugal force on the line, making it so stiff that it whips through grass and weeds as if it were a dull blade. But the line is better than a blade:

- It's safer. If you accidentally hit your foot with the whirling line, it may sting, but you won't be cut. And the line won't hurl rocks and sticks as a rigid blade would. Nor will it cut the tool's electrical power cord.
- The string can cut where a blade can't. When the line hits a solid object like a rock or stump, it just flexes and passes on instead of breaking as a blade might. Meanwhile every blade of grass next to that object has been whipped off.
- The mono also trims neatly around objects, such as young trees, that a blade could destroy.
- The line can even whip away grass and weeds right down to bare ground. This lets you clear a spot around the base of a tree, for example.
- The skinny string will reach in, around, and under fences, even difficult chain-link fences. Turn the trimmer on edge and the string will cut a neat line along the edge of your walks. When you're done, let the whirling string whisk the clippings off the walk.

Shopping advice

Know what you want before you go shopping so you can avoid buying too much tool for your needs. Or even worse, a trimmer that can't handle the work you have in mind. String trimmers come in four basic sizes, so first decide what size you need for the jobs you'll do.

Lightweights. If you live on a small suburban lot with a well-manicured lawn and very few weeds, you'll probably be happiest with one of these little trimmers. You can run them comfortably with one hand, leaving your other hand free to handle the power cord. Their little one-to-two-amp motors don't have the power to handle more than a few light weeds, but that's no problem; your main concern is trimming grass, which they do easily. Price: around $30.

Middleweights. Move up in size to a trimmer with a motor in the four-amp range and you have a very versatile tool. It will trim grass as well as the lightweights, but has the power to knock down all but the heaviest weeds. It's still light enough to handle easily. And the price is reasonable—around $60-$75.

Light heavyweights. These include electric trimmers with five- or six-amp motors, and gasoline trimmers with engines under 25 cc. A light heavyweight would interest you if you have to keep heavy weeds in check—such as in the DMZ between your lawn and a stand of woods.

A gasoline light-heavy would be a good choice if your property is large; it saves the hassle of dragging around a couple of hundred feet of power cord. Light heavyweight electrics generally cost over $75. The gasoline models start under $200.

Heavyweights. These are all gasoline-powered tools, most appropriate for commercial use. Some feature interchangeable cutting heads that can tackle anything from grass to brush and even small trees. Prices will run from around $250 upward.

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String trimmers

[Continued]

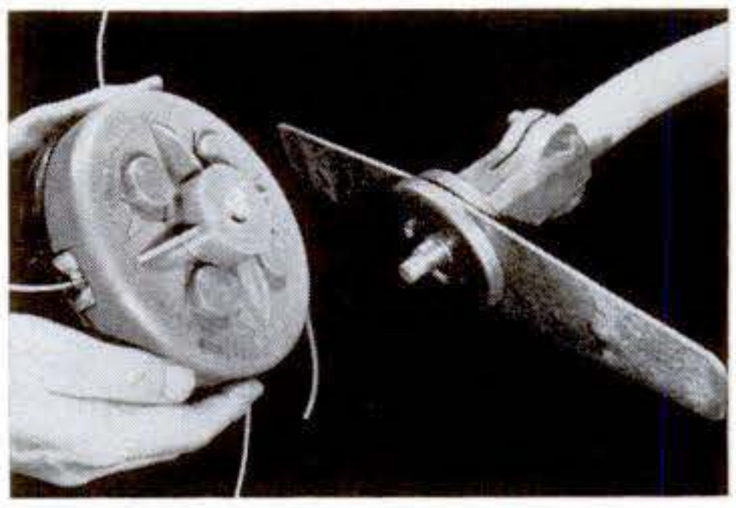
Be sure to do some comparison shopping. Look for these features:

- Cord locks. These keep the power cord from pulling out of the tool.
- Cord caddies. These let you store the power cord on the tool.
- Easy line replacement. Cutting lines wear down fast. On most trimmers, to replace the line you stop the tool and pull out fresh line from a spool attached to the drive shaft. Some trimmers do this automatically (see chart), others have a trigger-fed line advance.

On a few trimmers you have to tie or hook a new line on each time the old length wears down. This is the least convenient method, but it does eliminate the need for a heavy spool of line on the drive shaft, giving a slight edge in performance.

- Cutting line trimmers. Cutting with too much line extended from the spool can put a heavy strain on a trimmer motor. Most trimmers feature built-in knife blades that automatically cut the line to the proper length. This helps assure long tool life.
- Air filters. String trimmers kick up a lot of dust as they work. A good filtration system for cooling air—and for combustion air on gas models—is a must.
- Balance. Before you buy, handle the tool to see how it balances in your hands. Also, plug it in and squeeze the trigger to see how well the motor and cutting head are balanced. If you feel excess vibration, don't buy. Vibration will tire you out and shorten the tool's life.
- Double insulation. I like this system of shock protection better than the three-wire grounded approach. It lets you use lighter and cheaper extension cords.

One last buying note: When you pick up your trimmer, be sure to get a supply of extra cutting line. It goes fast, and is often hard to buy late in the season. PS



To advance Weed Eater's four cutting lines, press a button and pull to unspool. Head also fits Hoffco gasoline trimmers.

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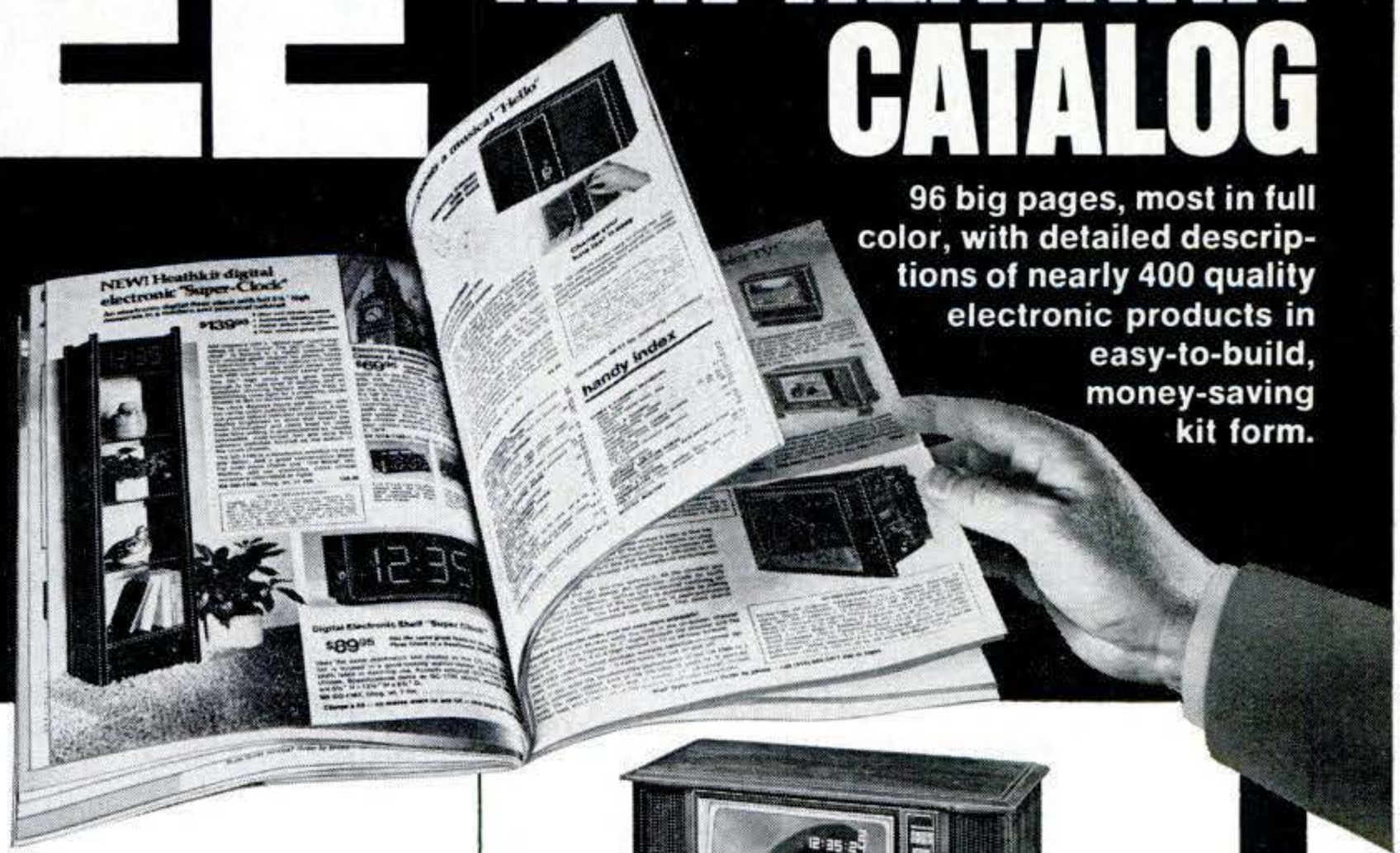

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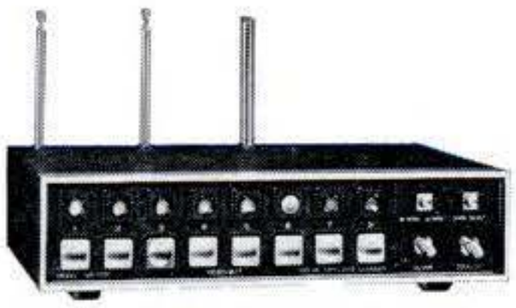

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Mini-tillers

–a lot of muscle for compact gardens

Light but efficient, the new models let you work the soil without wrenching your back

By E. F. LINDSLEY

Have you always wanted a garden, but dreaded the thought of spading it? You may even have toyed with the idea of buying a tiller, only to be put off by its size, weight, cost, and general intractability.

All that's changed. The new mini-tillers, first introduced by Gilson [PS, Feb. '76], are now available from many manufacturers. The little ground-churners have some big advantages:

- They cost less—about $150 to $200, compared with the $230-$460 tag on standard tillers.
- The minis weigh only 50-75 pounds, instead of the standard 150-200. And most fold up for transport and storage.
- Lower horsepower—usually two hp instead of the 3½ to eight hp on the standards—means lower fuel costs.
- They operate easily. Both worm-gear and chain drive are offered, but chain drive seems to be the trend; makers say it puts more power into the tines.
- The minis have good soil penetration and fine chopping action, even though tine diameter (length from tip to tip across the shaft) is nine or 10 inches, instead of the 13- or 14-inch spread on big tillers. The really big difference, however, is in the use of 1/16" spring-steel tines instead of the rigid, ¼"-thick, slugger tines on the heavyweights. To appreciate these new tines, you have to watch a tiller work. Each time a tine

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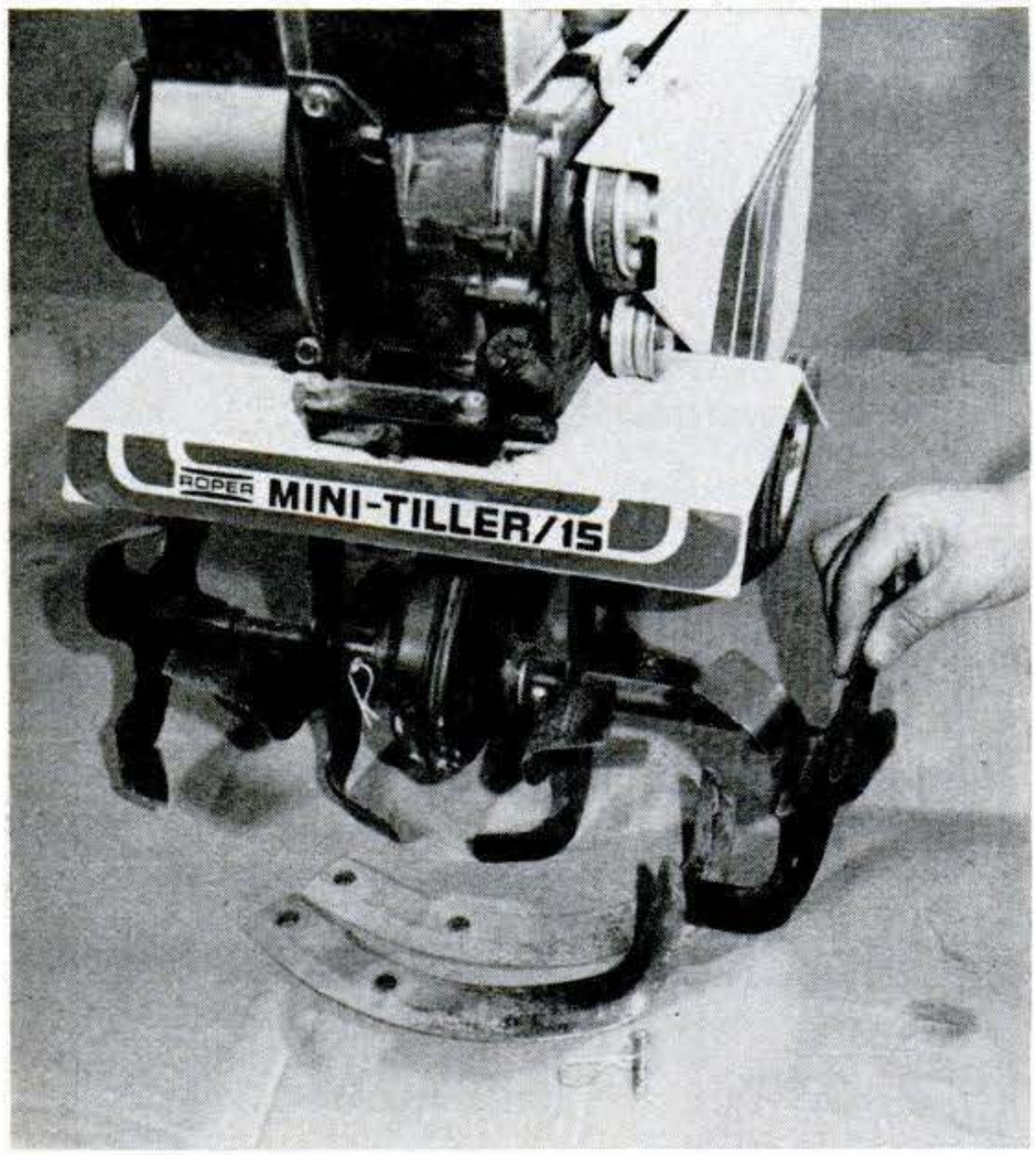
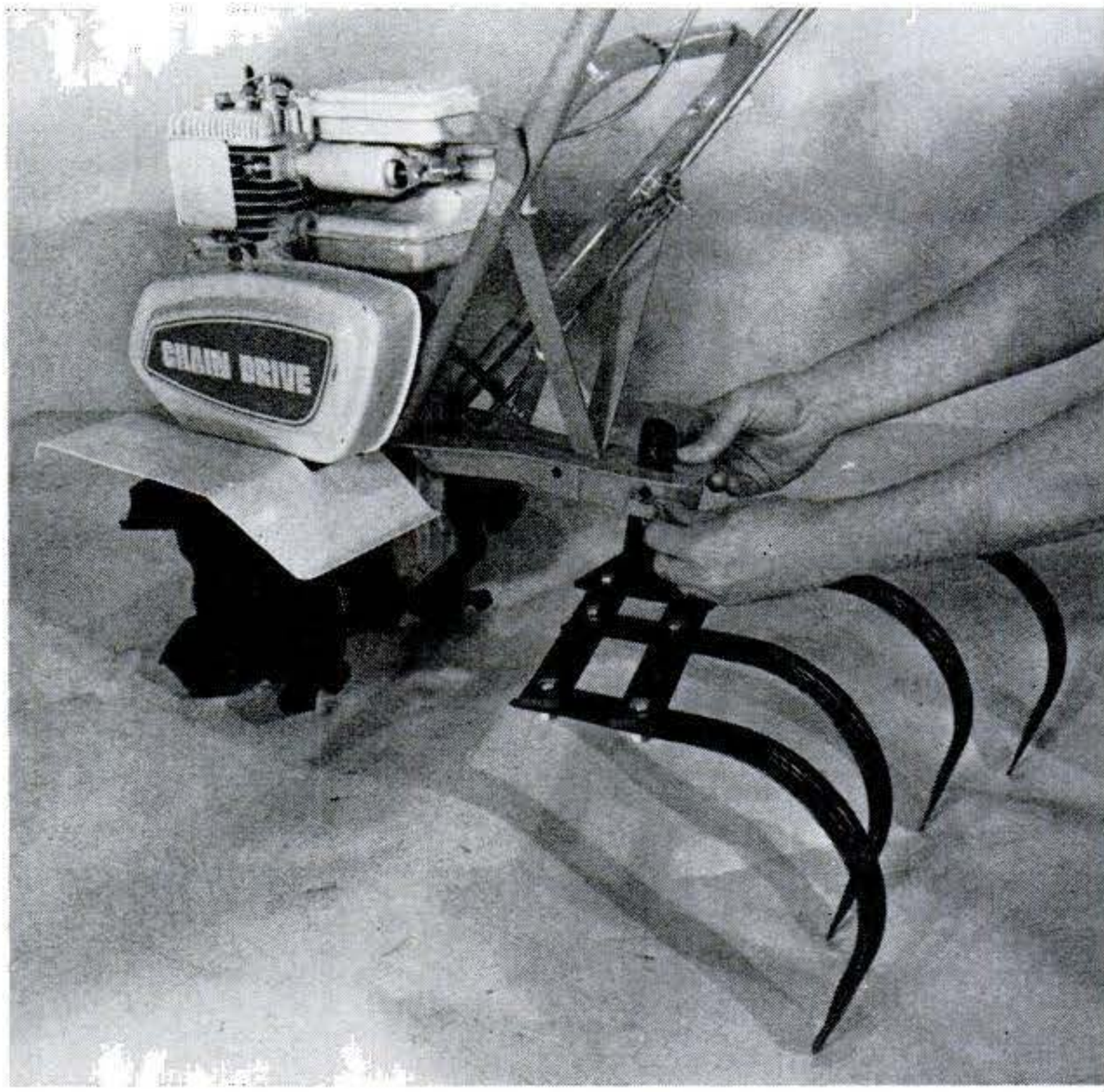


Thinner tines make for good penetration with less bounce. The big difference in size between thick, standard tines (foreground) and thin, flexible tines is shown above.



Swapping tines for paddle-like wheels converts latest Gilson tiller into a walking tractor. Spring-tooth drag for combing out weeds is one of several tools you can pull.

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18 mg. "tar", 1.2 mg. nicotine av. per cigarette, FTC Report DEC. '76.

Tubular frame on this Feldman (above) cuts weight, making it easy to heft into trunk. The frame also gives great visibility when you work in close to plants.

Tilling's not always this easy (left), but one hand is all you need to work up an existing garden. Thin-tined Roper aerates soil, chops and buries old plants.

comes around and whacks down into the soil, you get an opposite reaction that tends to lift the tiller off the ground. The harder or rockier the soil, the more the bounce. It can be like holding an engine-powered kangaroo by the tail. The standard solution has always been to make the tiller heavier.

The springy, smaller-diameter tines on the minis, however, penetrate the soil more easily. Their smaller radius also means less leverage for kickback. In spite of less weight, the minis chop and mulch old vegetation more cleanly. The tines have a vibrating, twisting, flexing action that breaks up the soil and lets them bypass stones without head-on impacts. Naturally, all this requires supergrade steel, but tine breakage is so rare that makers offer unquestioned replacement for life.

Disadvantages of the minis? Only one: Busting virgin sod is not going to be easy or fast. You can do it—but if you have plans for a big first-time garden, you'd be smart to rent a big, rear-tine sodbuster or get a commercial operator to do your pioneering. Once you have your garden started, you can use a mini-tiller for yearly preparation—unless you have 40 acres and need a mule.

Another trade-off favors the small tiller: Come midsummer, you'll undoubtedly find the weeds on your plot burgeoning more plentifully than the vegetables. Now, the time you may have lost in using the mini earlier will be regained in cultivating with it. The mini can be worked almost like a carpet sweeper, slipping between rows, nuzzling up close to plants, aerating and breaking up rain-packed soil, and nipping out sneaky weeds. None of these little giants has power reverse, but their lightness makes it unnecessary—unlike larger tillers, where reverse is a must for cultivating.

TYPICAL MINI-TILLERS FOR '77

MAKE AND MODEL	Hp	Max. width (in.)	Dia. tines (in.)	Wt. (lb.)	Approx. price	Features
ARIENS Gard-N-Yard Tool	2	21	10	63	$189.95	Worm-gear drive
ATLAS Mitey Mite	2	18½	10	65	159.95	Handle-mounted throttle
FELDMAN 72335 Budget	2	18	10	52	179.95	Tubular frame
GILSON Compact Tiller	2	18	9	51	190.00	Walking-tractor conversion
51104	2	22	11	65	200.00	
MERRY TILLER "Minnie"	2	18	n.a.	70	199.50	
MTD Till-It 2	2	n.a.	10	60	189.95	Handle-mounted throttle
MURRAY 7-1000	2	24	11	70	n.a.	
ROPER Mini-Tiller	2	15	9	75	189.95	Handle-mounted throttle
TORO 58307	2	22	n.a.	n.a.	239.95	
WARDS 89FR39000R	2	18	9	51	179.95	
WHEELER WTP-27	2	18½	10	72	150.00	

What to look for

To get the most in cultivating convenience, check for the following:

- Quick, smooth clutch and release. Smooth, finger-tip clutch control without grabbing is vital for

Continued

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The Dodge Power Wagon carries a lower base sticker price* than any other four-wheel-drive pickup built in America. Lower than Ford, lower than Chevy, and even lower than Jeep. And it's the only four-wheel-drive pickup available with a Club Cab. The Dodge W100 base price is the lowest of all four-wheel-drive pickups built in America.

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When you want four-wheel drive, you want it tough. You want a truck you can count on to carry the load over country that would whip an ordinary pickup. You want a truck that can take a beating and come out of it looking good. You want a Dodge Power Wagon.

Dodge builds a full line of Power Wagons for 1977, including Club Cab and six-passenger Crew Cab models. Whether you're buying or leasing, whether it's one truck or a fleet, you can count on Dodge four-wheel-drive Power Wagons. Special tires shown not available as factory equipment.

**Price comparisons based on manufacturers' suggested retail prices, not including destination charge, taxes and options.*

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close-in cultivating. You want to sneak the tines in as close to the plant root area as possible, and then stop instantly. And, you don't want a clutch that causes the tiller to pounce like a cat all over your prize tomatoes.

- Good tine visibility. To keep from shredding your crop, you've also got to be able to watch the tines closely. Check to see if the stone shield can be removed easily, in case it will obstruct your view of the tines when they're in a narrow setup for cultivating.
- Multiple tine width adjustments. Not all tillers can be set up for several work widths, from a narrow one of perhaps six or seven inches up to full width.
- Hand throttle on handle. Only a few mini-tillers have this, but they all should. It's needed for accurate control, so you can ease down to a slow putt-putt in tight spots, and speed up in less critical areas. It's no problem, however, to rig one with a throttle-cable kit.
- Wheel power conversion. Substituting wheels or wheel-like metal paddles for the tines gives you a two-wheel tractor. You can then attach such rear-mounted pull tools as a spring-tooth cultivator to snag out quack-grass roots; furrow openers and hillers for planting and soil control; and V-shape, horizontal-blade plows to rip under weeds.

For some, of course, the greatest merit of a mini-tiller is that it can be hauled in a car trunk. Some tillers fold better than others; some have removable wheels to squeeze down those last few inches; and some just won't quite fit unless you wire down the trunk lid at half mast. Still, it's much easier to lift 50 or 60 pounds of folded machinery than a 175-pound monster with a defiant handle. But never plan to tote your tiller flopped over on its side in a car trunk. Gas and oil leaks can be dangerous.

If you're new to gardening, even the relatively low mini-tiller prices may give you pause. Look at it this way. If you buy a good product and take reasonable care of it, you can expect at least 10 years of service. The fuel cost is trifling—and an enormous bargain when you stack what half a gallon of gas in a tiller can do against what your own muscles can do. Thus, if you can produce $15 to $20 worth of food each year—and most gardeners vastly exceed that—your tiller will more than pay for its keep. PS

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Reporter takes both color and black-and-white peel-apart pack film. It weighs 26 ounces, folds, uses flash cubes, costs $57.

Pronto Extra takes SX-70 film. It has a self-timer and tripod adapter (tripod is extra). Price: $70.

Instant-picture cameras
–news and new models from Polaroid

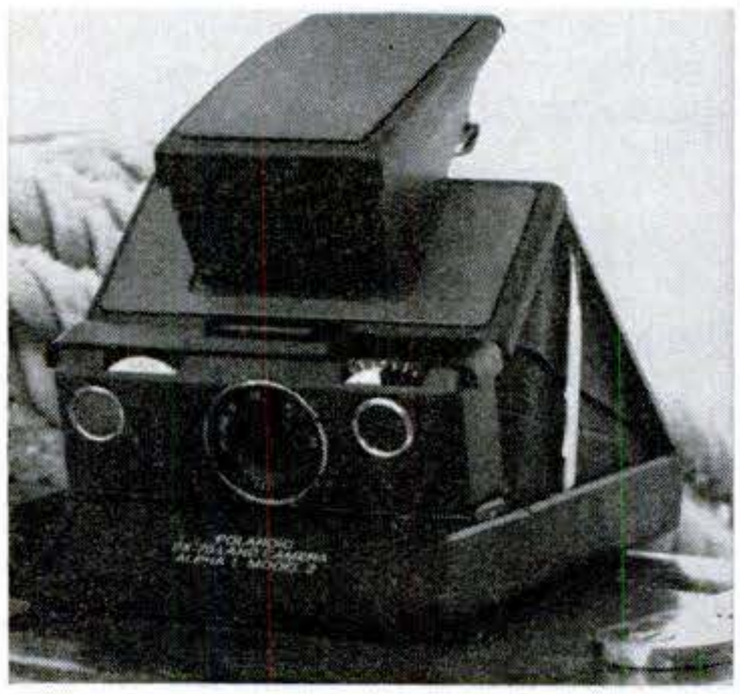
A new camera design, new models of existing cameras, a new film size, and hints of important new developments to come marked the Polaroid Corporation's celebration recently of the 30th anniversary of the introduction of its first instant-picture camera.

The Reporter (shown above, left), the new design, is one of three new pack-film cameras being introduced. It folds to a compact 2½-inch thickness, and takes both color and black-and-white film in both square format and 3¼-by-4¼-inch print size. The other two are the MinuteMaker Plus ($32, color and b&w) and the MinuteMaker ($25, color only). The pack film, you'll recall, includes the beautiful Polacolor, but (the bad news) has the penalty of that messy peel-apart feature.

Using the non-messy SX-70 system are four new models: three Prontos (two of which have such features as detachable self-timer and a tripod adapter) and a new Alpha Model 2. It does everything the top-of-the-line Alpha 1 does except smell of leather—which it can't because its covering is plastic. However, at $180, it costs $53 less.

The new film size—Polacolor in 8-by-10—is designed for use in an 8-by-10 camera. After exposure, the print is run through a motor-driven processor to emerge in brilliant color. Along with still larger print sizes to come, the film promises a revolution in studio photography.

Another revolution in the making may be heralded by the 500th patent granted to Dr. Edwin H. Land, inventor of the Polaroid instant-picture systems. It is for a film-pack battery that would supply power not only for the camera, but also for camera accessories such as electronic flash.—*Everett H. Ortner*



SX-70 Alpha Model 2 has ultramodern electronics (including the ability to meter fill-in flash). It's $180.

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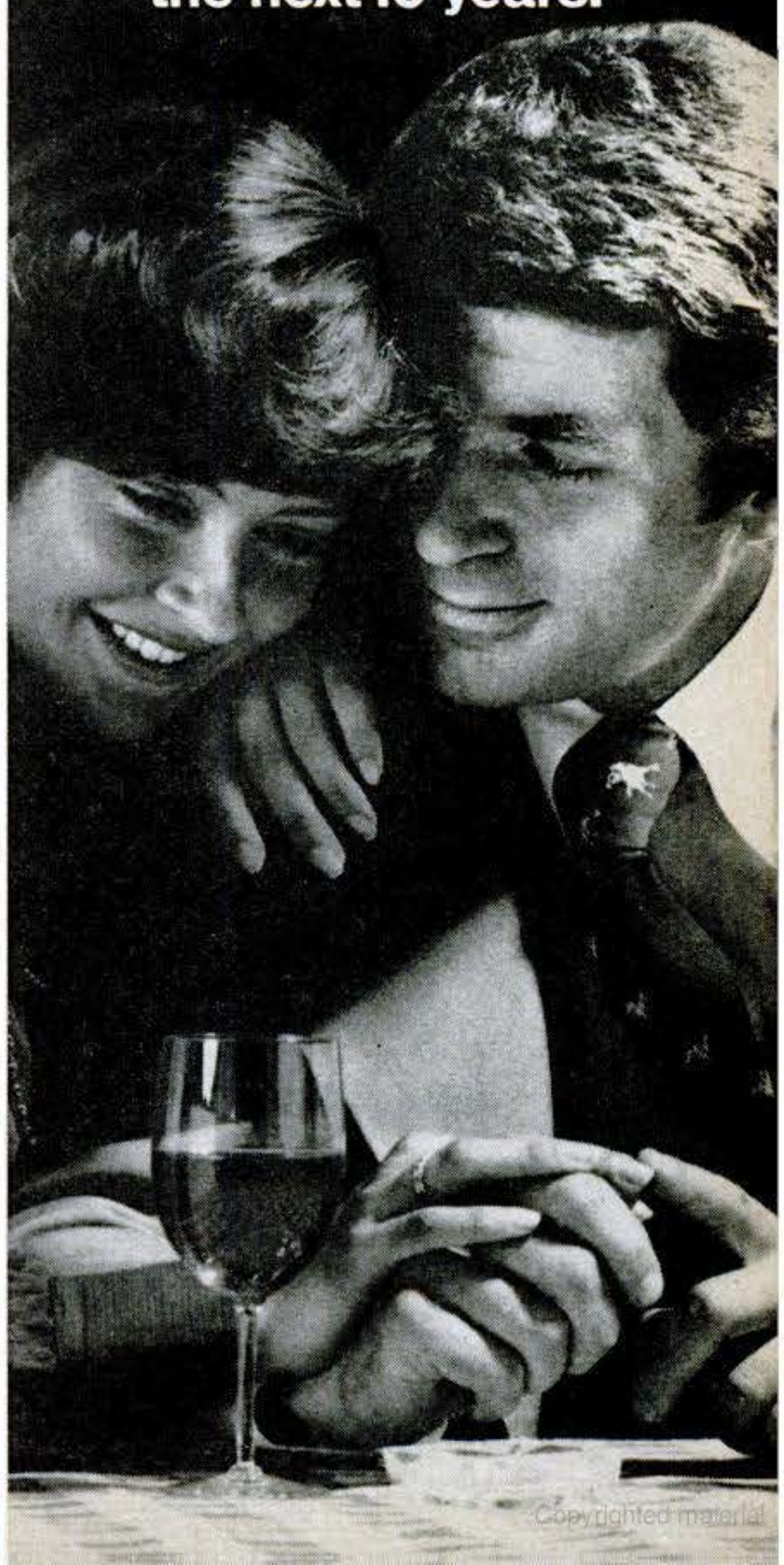

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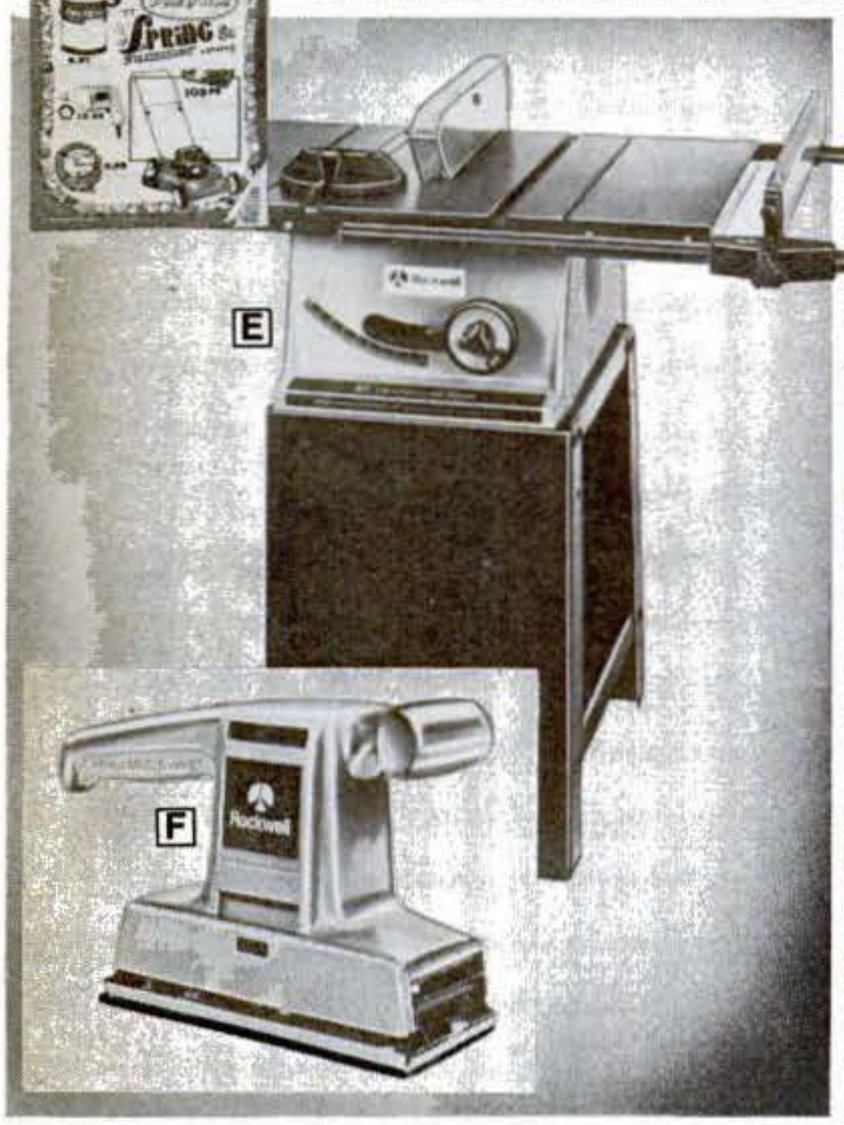

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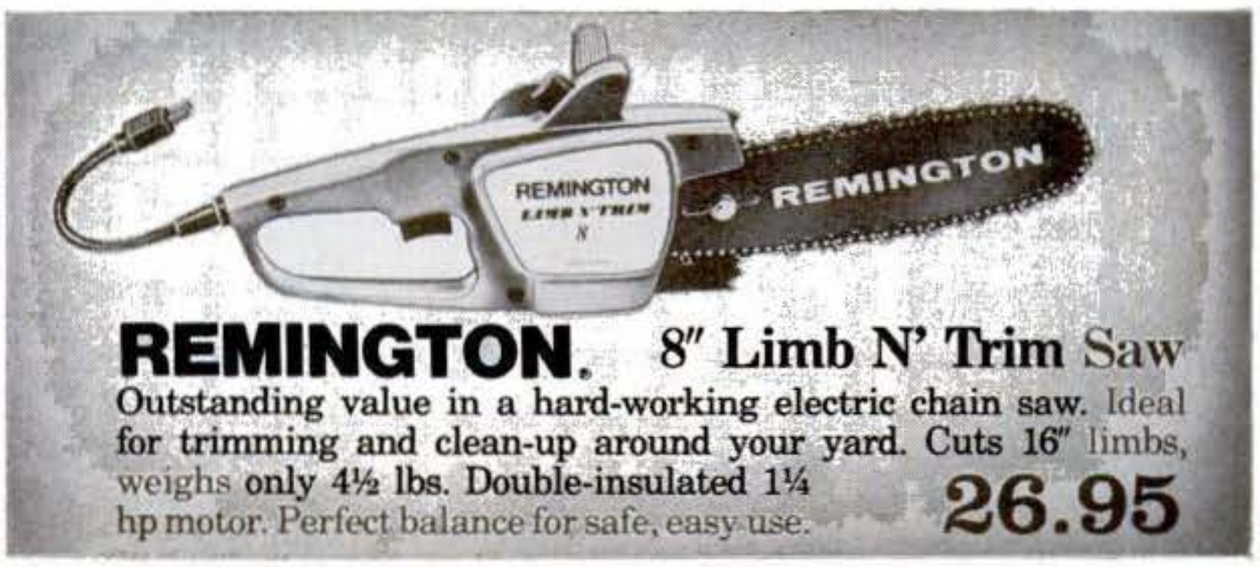

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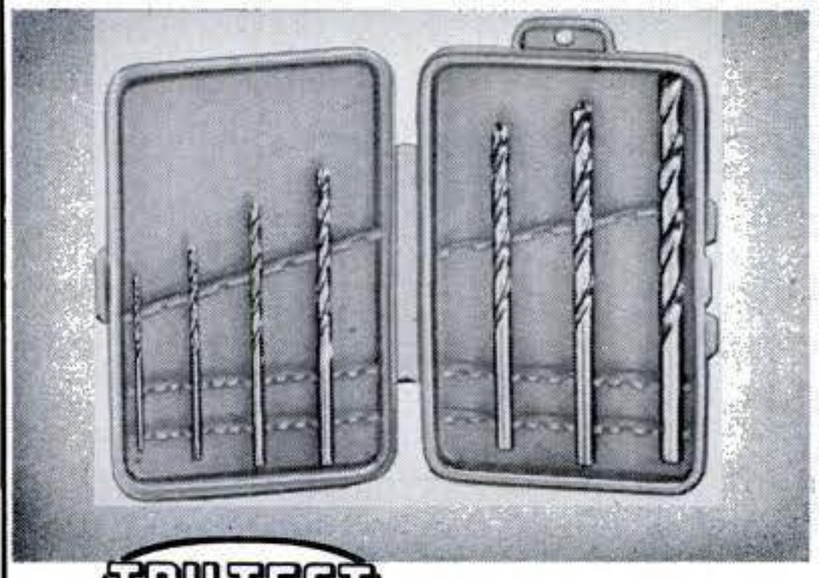

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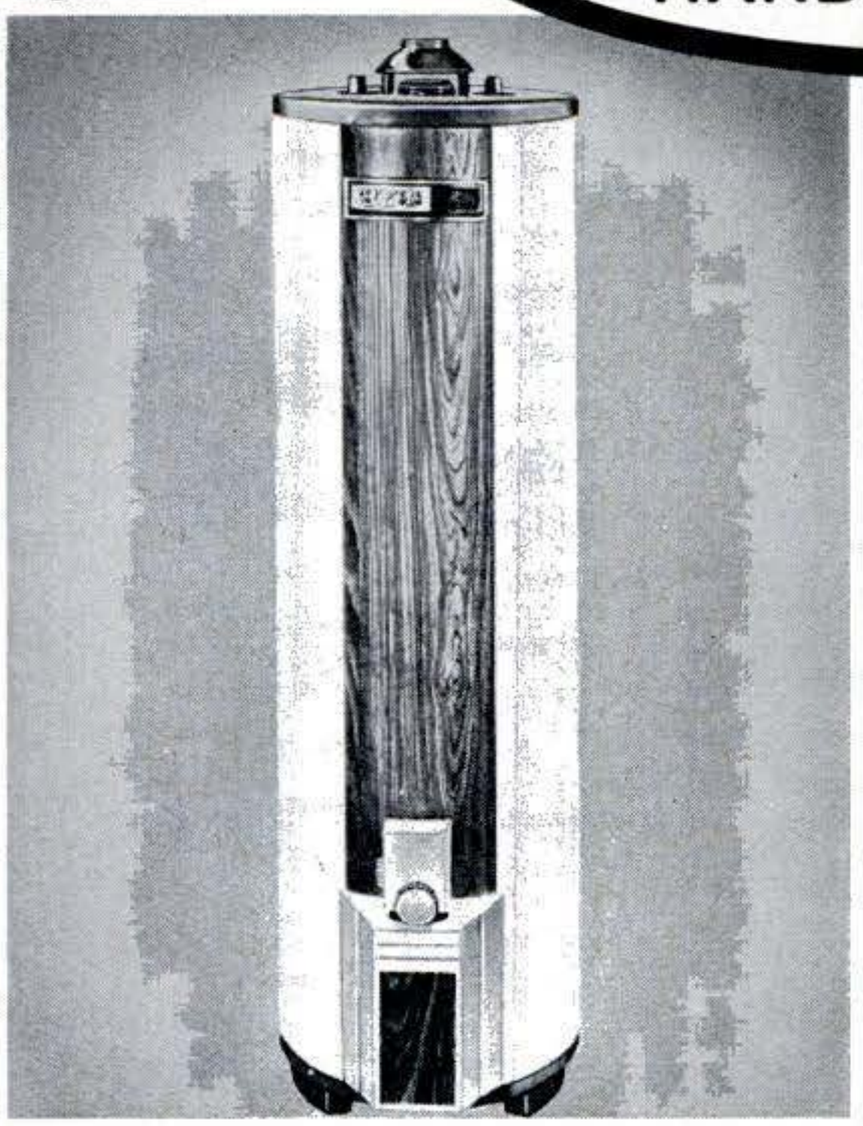

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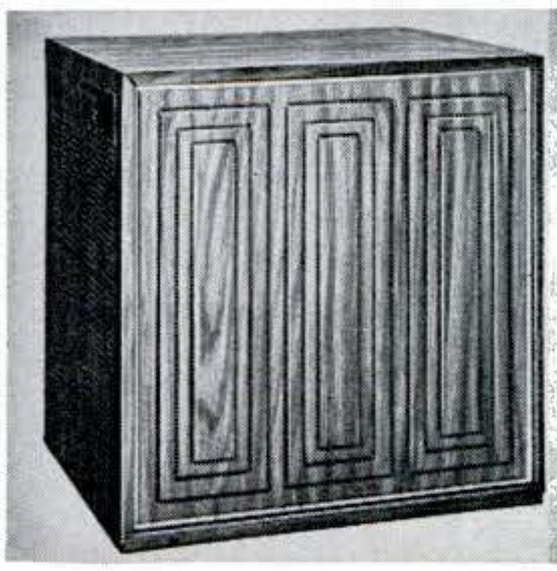

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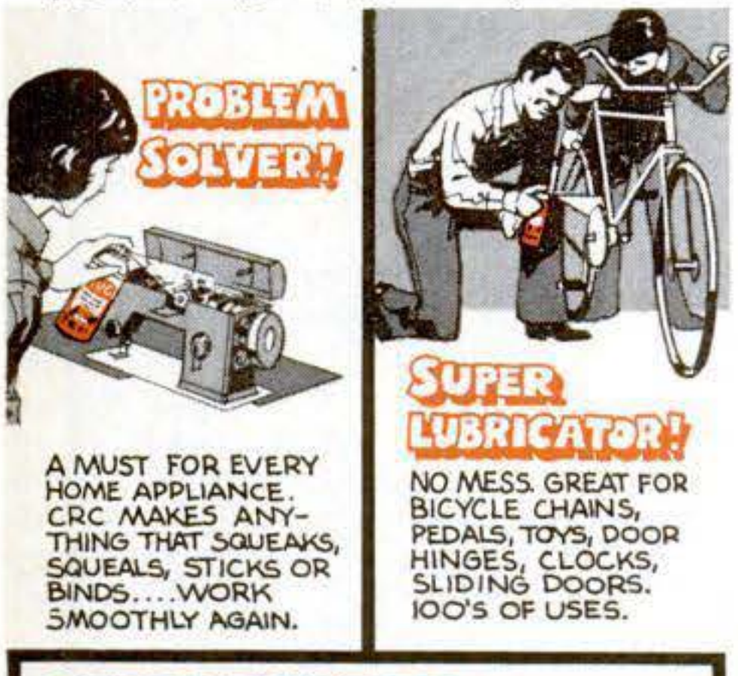

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ON TARGET

By PAUL WAHL

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The basic rifle is the HK300, a semiautomatic with a five- or 15-shot clip magazine. It's chambered for the popular .22 Winchester Magnum Rim Fire cartridge. The 19.7-inch barrel has a polygonal twist bore (no lands and grooves, as in conventional rifling) claimed to reduce wear as well as increase velocity (about six percent) and effective range.

The standard sights are a V-notch rear and post front, respectively adjustable for windage and elevation. A special clamp-type scope mount is available. The rifle is 39.4 inches long and weighs 5.7 pounds.

The HK300 Grade III, shown above, is priced over $5000. If your tastes are less regal, there's the standard model for $215; or with deluxe stock, $275. In between are the select Grades I and II at about $1250 and $2250.

This excellent .22 autoloader is a product of Heckler & Koch GmbH, Oberndorf/Neckar, West Germany, maker of the famous G3 rifle used by the Bundeswehr. Distributor of the autoloader in the U.S. is Heckler & Koch Inc., 933 N. Kenmore St., Arlington, Va. 22201.

New .410 shotgun

Savage has just introduced a neat little .410 over/under, Model 242, at the easily affordable price of $124.50. This is a hammer gun with top-lever opening. The 24-inch barrels are chambered for three-inch shells and bored full choke. Its frame is case-hardened in colors; the barrels are blued. Stock and foreend are walnut, the pistol-grip is checkered and capped. Model 242 is just 40 inches long and weighs about seven pounds.

Although it's often selected by beginners because of the very light recoil, I do not recommend the .410 to novice gunners. With about 25 percent less shot than a 20-gauge field load, the .410 is hard to hit with at any range, and ineffective beyond about 30 yards. But if you're experienced at wingshooting and looking for a challenge, you can have a lot of fun with this smallbore. It's a handy gun to carry afield for pest control and small-game hunting. From Savage Arms, Westfield, Mass. 01085.

Fiberglass rifle stocks

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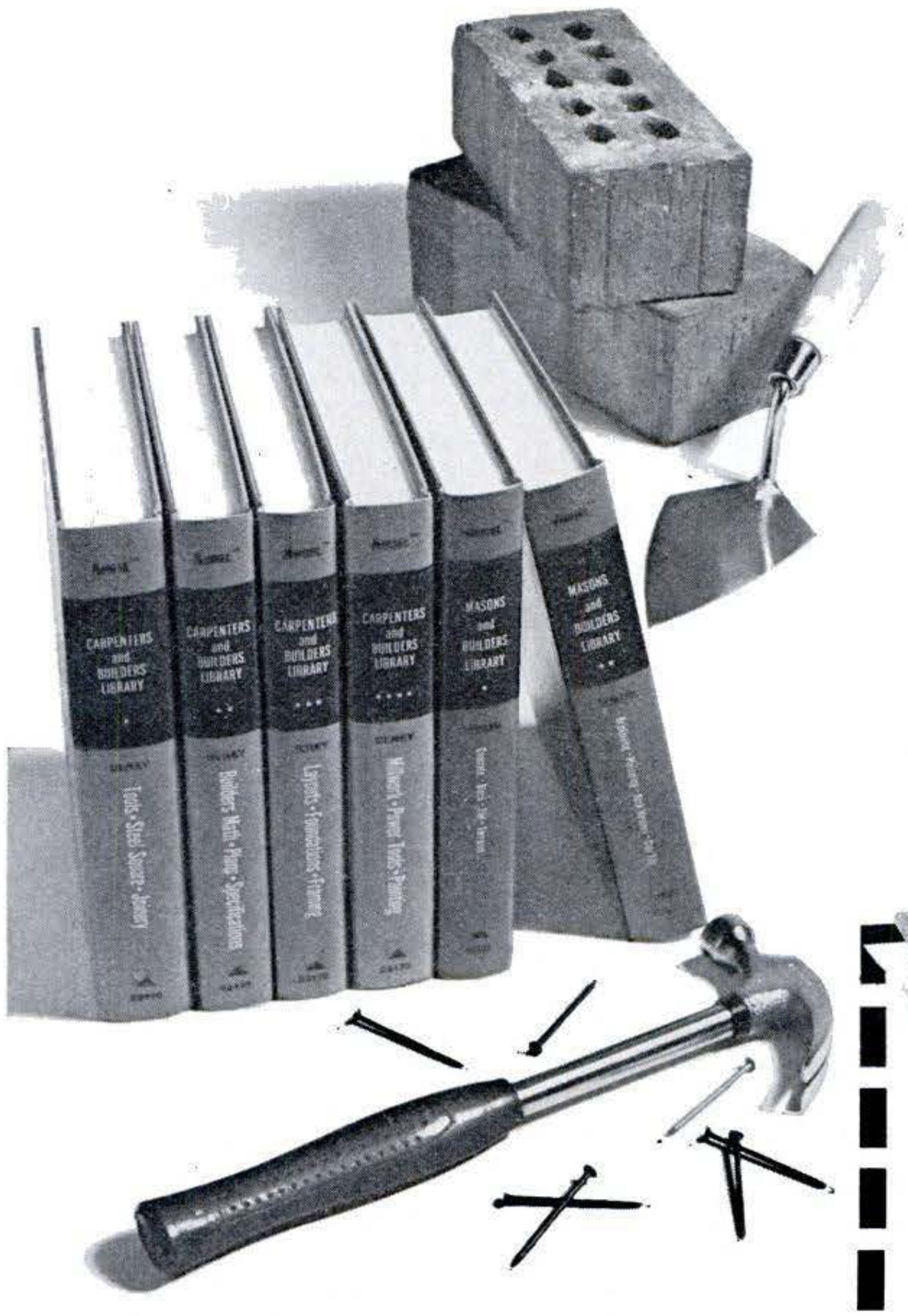

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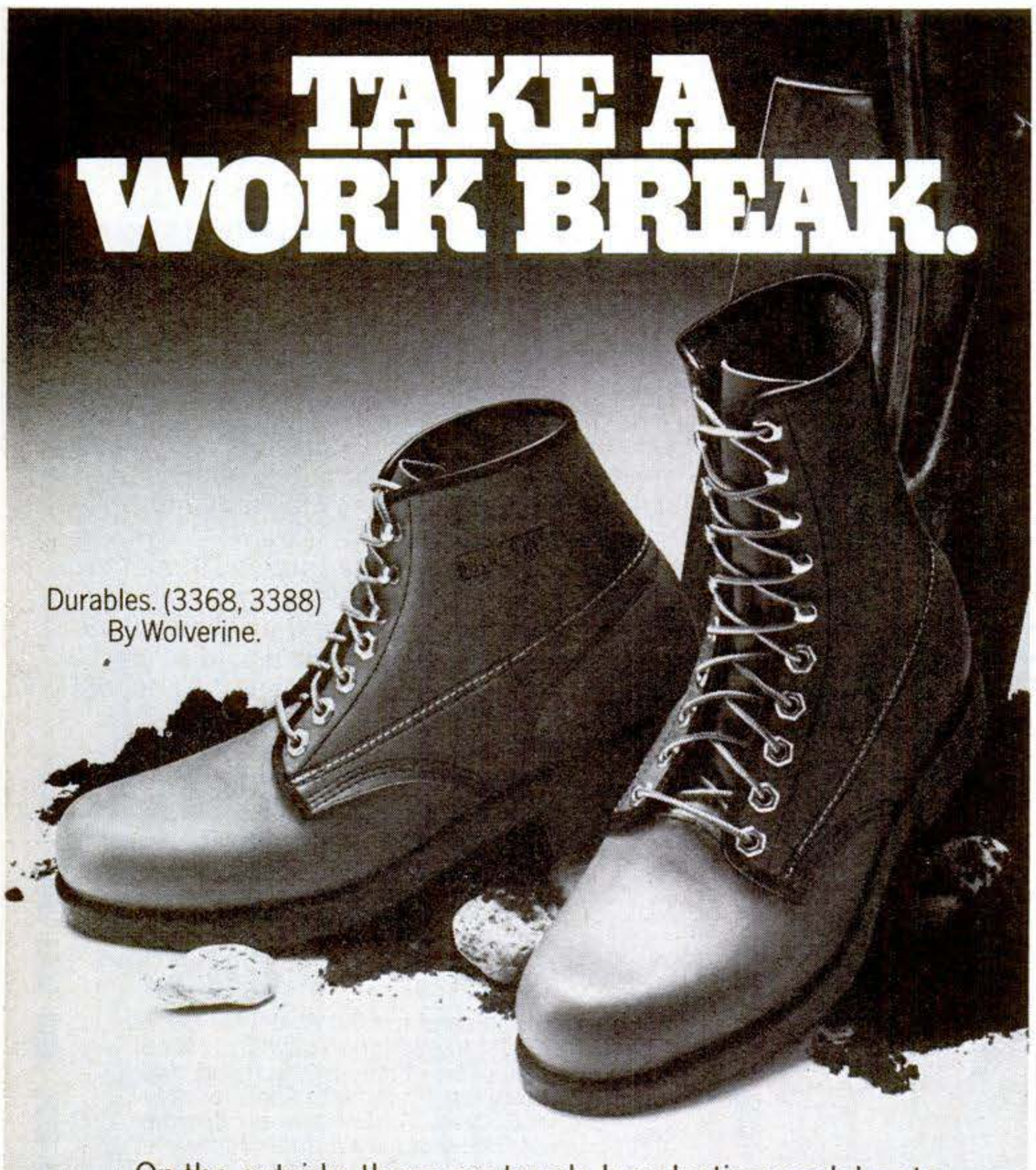

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On target

[*Continued*]

sorbs or loses moisture, the wooden stock swells or shrinks. The resultant warpage exerts pressures on the bedding of the action and barrel, changing the point of impact. Extreme variations in temperature have a similar effect. Thus, a rifle accurately sighted-in before you leave home may be way off target in the hunting field.

Fiberglass is an answer to the need for a stable stock material. Weather conditions have no effect on it. And there are other pluses: A fiberglass stock is not only stronger but also up to 1½ pounds lighter than typical sporting-rifle woodwork. Stability is essential to accuracy, and a fiberglass stock can make the difference between a hit and a miss. A fiberglass-stock rifle may look plain, even ugly, but it will outshoot the prettier wooden-stock kind.

Brown Precision Co. (5869 Indian Ave., San Jose, Calif. 95123), a pioneer in this field, now offers fiberglass stocks for hunting as well as target rifles, and recently introduced the High Country (shown at the bottom of p. 66), an ultra-light, ultra-accurate sporter custom-made in its shop.

The High Country has a standard Remington Model 700 action and barrel epoxy-bedded in a foam-filled fiberglass stock finished in brown, low-luster, nonreflective, acrylic enamel; sling swivels and recoil pad are factory-installed. Depending on the caliber, the High Country without scope weighs from 5 lb. 14 oz. to about 7 lb. Three or four ounces can be pared from the rifle's weight by turning down the barrel to a slimmer contour (at an additional cost of $65). Calibers include: .243, .25-06, .270, 7mm Magnum, .308, and .30-06. Basic rifle is priced at $395, the magnum model is $22 extra.

Brown Precision sells fiberglass stock blanks at $65 up. However, fitting and finishing one is no job for an inexperienced amateur to tackle. The company will stock your barreled action for $130 up.

Although Brown's hand-layup fiberglass process makes a superior stock, it isn't cheap enough for mass production. Similarly stable and durable synthetic stocks, however, can be injection-molded for less than it costs gun manufacturers to make wooden stocks today. But the shooting fraternity generally is turned off by "plastic" gunstocks and will have to be educated in the practical advantages of synthetics. Undoubtedly, the gunstock of the future will be a molded synthetic. Walnut is scarce and expensive; other hardwoods are less than satisfactory substitutes. It's just a matter of time before most gunstocks are non-wood.

Good reading

The Bolt Rifles, by engineer Stuart Otteson, provides detailed design analyses in laymen's terms. Winchester Press, 205 E. 42nd St., N.Y.C. 10017. PS

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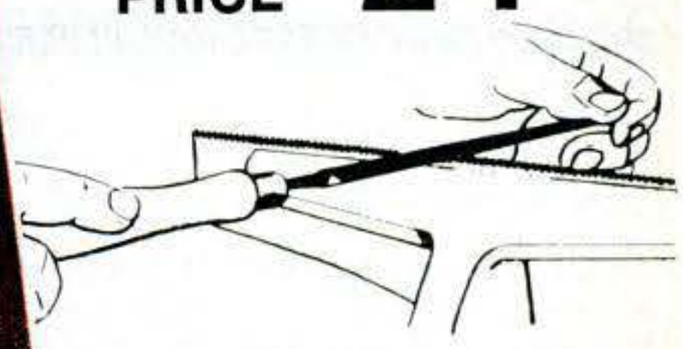

If you're like most do-it-yourselfers, you probably do most of the routine woodworking jobs around the house yourself and *pay* to get the fancier work done. Yet the real satisfaction of woodworking comes from doing those fancy jobs yourself: making a wall of handsomely grained built-ins... wood-panelling an entire room ...constructing a table with a perfectly matched veneer top. Yes, you can do all of these fancy jobs yourself *even without experience* when you've got a copy of CABINETMAKING AND MILLWORK as your guide.

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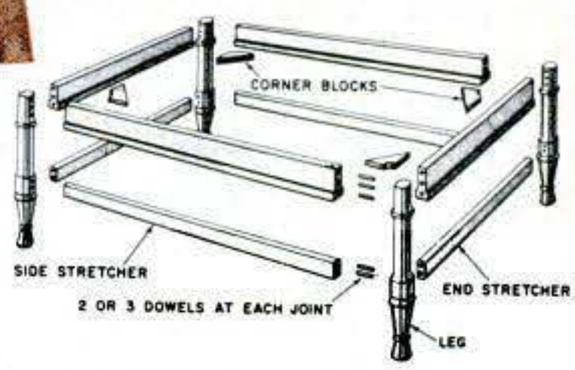

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Sharpening jigs

–use them like a pro

Want to stop wasting time on dull tools? These jigs will sharpen almost every one

By MACK PHILIPS

Are your drill bits, saws, plane blades, and chisels always dull or out being sharpened just when you need them for a job? If you own a few basic sharpening jigs, you won't have to worry about this happening again. The jigs can help you keep most of your cutting tools as sharp as the pros do.

Don't expect to zap a dull tool into one of these jigs and get instant perfection. Black & Decker's drill-bit sharpeners, for example, appear to be as easy to use as an electric pencil sharpener, and they are—once you understand the six pages of instructions. And for any jig you must follow more general directions:

- Position the tool and adjust angles to exactly match the original cutting-edge angles. Consult reference charts where possible.
- Cut sharp. Files must be sharp, grinding wheels freshly dressed and trued, abrasive paper fresh, honing stones flat and true.
- For carbide-tipped tools, filing is out; so is using the B&D drill sharpener. Instead, use a silicon-carbide wheel on a bench grinder, or silicon-carbide abrasive paper. A special stone should be used for honing.
- Use proper shielding to ensure operating safety. (Shields have been backed off in some of our photos to show the operation better.)

All of the jigs I tried are really resharpening devices. Badly messed-up drill points or broken drills should be at least roughly repointed on a bench grinder before you use a jig. All of the jigs will give the standard 118-degree included angle to the drill point. The General and Sears units are adjustable for different point angles.

You might be tempted to use jigs of the General and Sears type against the side of a grinding wheel. Don't, unless you use a wheel designed for that service. One solution: Make a simple base to fit in place of the table of a stationary disk sander. Use an aluminum-oxide sanding disk. The jig is then fully adjustable and the grinding surface perfectly flat.

Universal jigs work well for straightedge grinding. You can grind—and even hollow grind—scraper blades, knives for jointers (up to about 4″ wide), plane blades, wood chisels, and cold chisels.

The circular-saw-blade jig has rollers, so you can joint the teeth of the saw (make them even) with a flat file if necessary. You'll need a separate jig if you want to set the blade teeth.

Handsaw filing is easy with a jig that fits over the blade and guides a file at an adjustable angle. You do need support for the blade—either a regular blade clamp or one improvised from 2x4's as shown in the photo at bottom left on the following page. To avoid danger of uneven filing with these jigs, count the file strokes given each tooth.

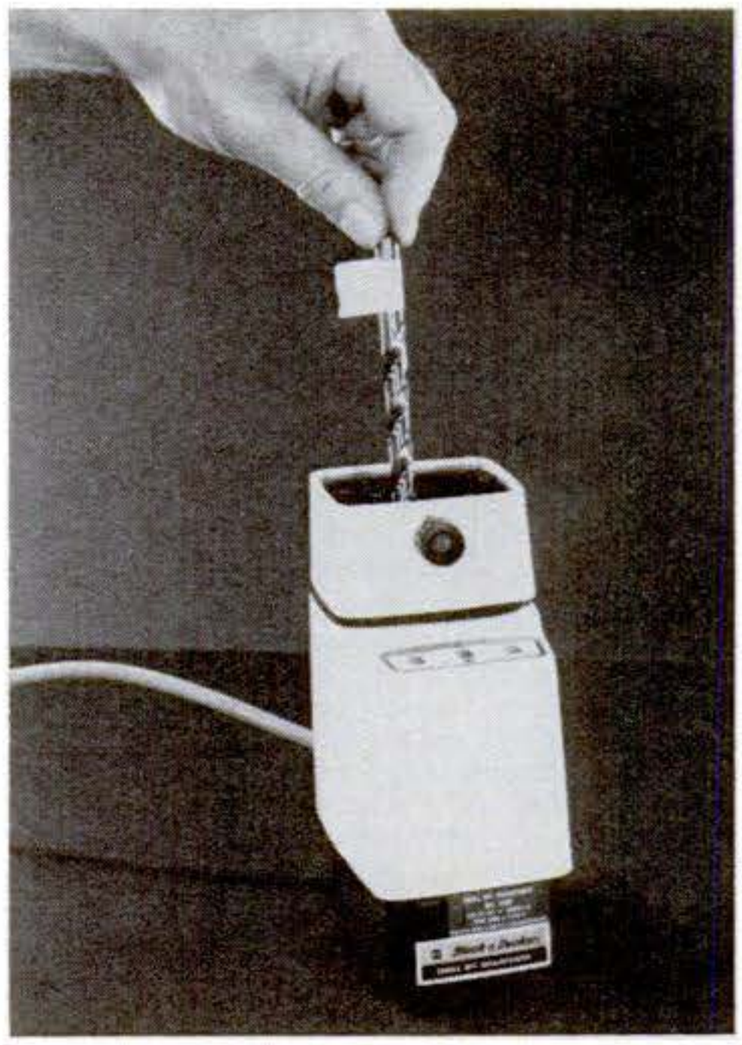
The honing jig will take tools such as plane blades and chisels up to about 2½″ wide. The roller at the rear adjusts up and down to control the angle. Such a jig is really a finishing device—ideal, for example, for honing a tool after sharpening on a universal jig.

Fairly frequent touchups of chain-saw teeth are essential. If a chain needs a professional sharpen-

[Continued on page 76]

WHO MAKES THEM

Belsaw, Field Bldg., Kansas City MO 64111; **Black & Decker,** Towson MD 21204; **Eclipse, James Neill, Inc.,** 417 Woodmont Rd., Milford CT 06460; **Foley,** 3300 5th St. N.E., Minneapolis MN 55418; **General Hardware,** 80 White St., New York NY 10013; **A.D. McBurney,** 1610 Victory Blvd., Glendale CA 91201; **National Camera,** 2000 Union Ave., Englewood CO 80110; **Nicholson,** Box 728, Apex NC 27502; **Sabre Saw Chains,** Niagara Falls NY 14304; **Sears,** mail-order catalog, retail stores; **Speed Corp.,** Canby OR 97013; **Spe.dy, One Minute Tool Co.,** Box N-1031, New Bedford MA 02746; **Stanley Tools,** 600 Myrtle, New Britain CT 06050.



Pencil-sharpener-style Black & Decker drill-bit sharpener is easy to use if you follow instructions. With built-in motor, it's $28; as drill attachment, $15.

Turn page for photos

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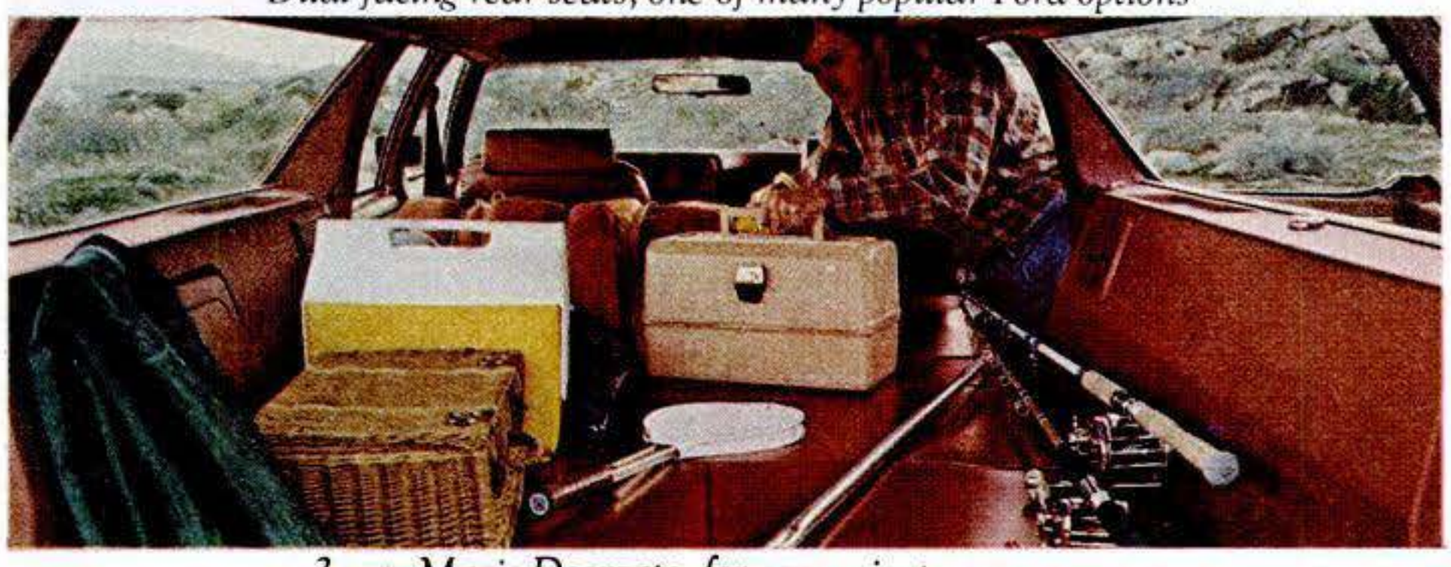
Ford LTD Country Squire

Ford LTD Wagon holds more and is rated to haul more than Chevy, but is priced about the same.*

Dual-facing rear seats, one of many popular Ford options



3-way Magic Doorgate, for convenient cargo access

Available lockable side storage compartment

Below deck lockable storage space

Again this year, The Wagonmaster—Ford—gives you more of what you buy a wagon for. Some wagon makers, like Chevrolet, have cut down their "full-size" wagons, making them narrower and shorter, so they hold less. But not Ford.

The 1977 Ford LTD is the full-size wagon that's kept its size. Compared with the "down-sized" Chevy, Ford LTD Wagon

- **has more room to hold things,**
- **more hip and shoulder room to carry 6 in comfort,**
- **an optional extra half ton rated towing capacity.**

**With optional heavy-duty trailer towing package, Ford LTD is rated to haul more than Chevy. Yet based on sticker price comparisons of comparably equipped vehicles, Ford LTD is priced about the same.*

If your family is growing bigger, why buy a wagon that's growing smaller?

Ford gives you more of what you buy a wagon for.

FORD

When America needs a better idea, Ford puts it on wheels.

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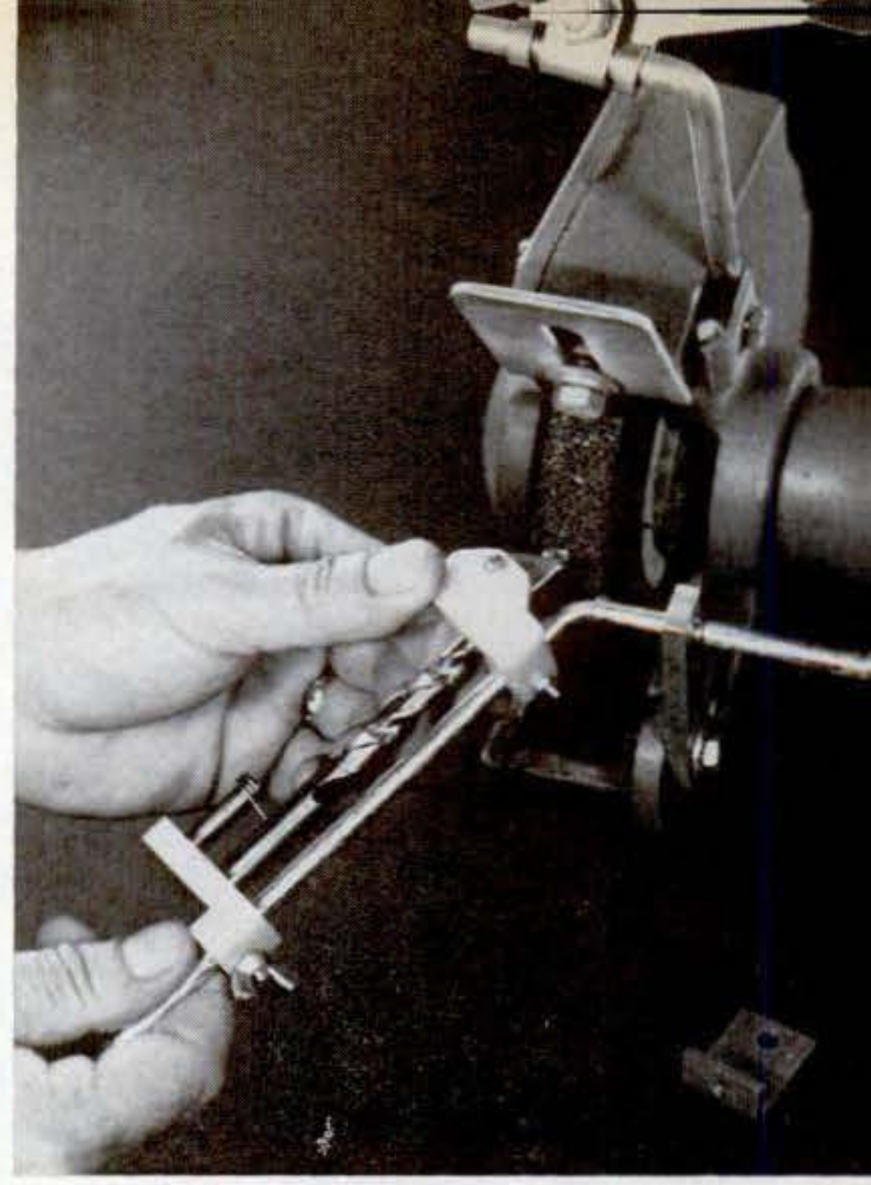
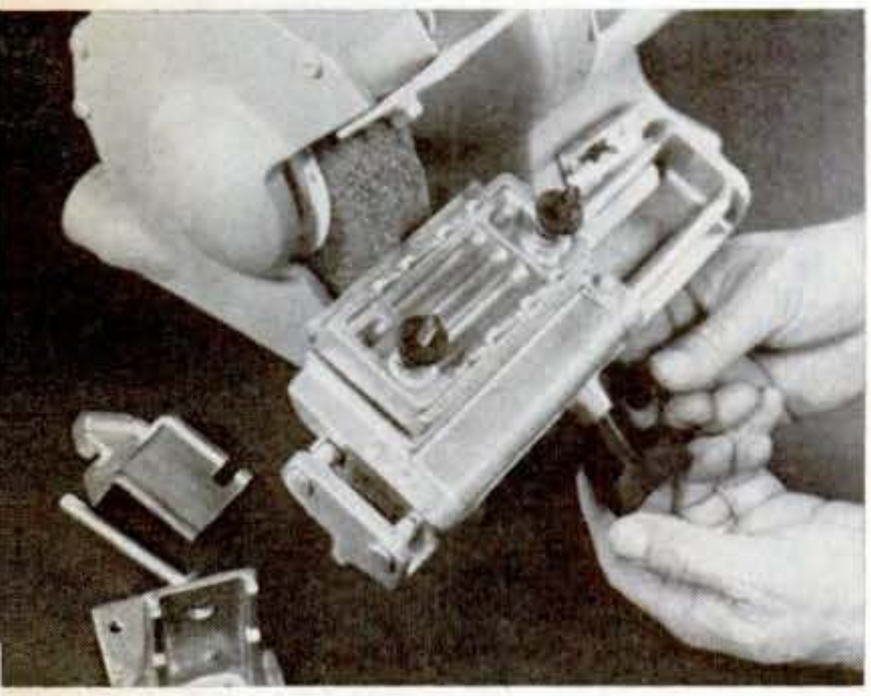
Drill-bit jig from Eclipse rides on eccentric wheels over a sheet of abrasive paper. English jig is made almost entirely of precision-molded plastic. $12.

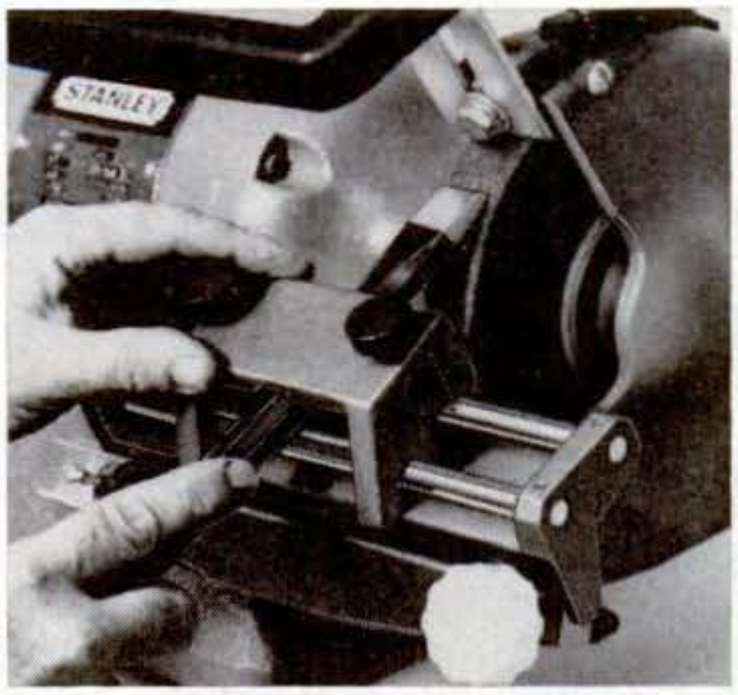
Attached to a disk sander, this jig will sharpen twist bits with 1/8- to 3/4-in. diameter. Sold by General and Sears for $10, it's adjustable for point angle.



Simple and inexpensive jig from Spe.dy [trademark] attaches to bench grinder. It also comes with a bracket for bench mounting. About $6.

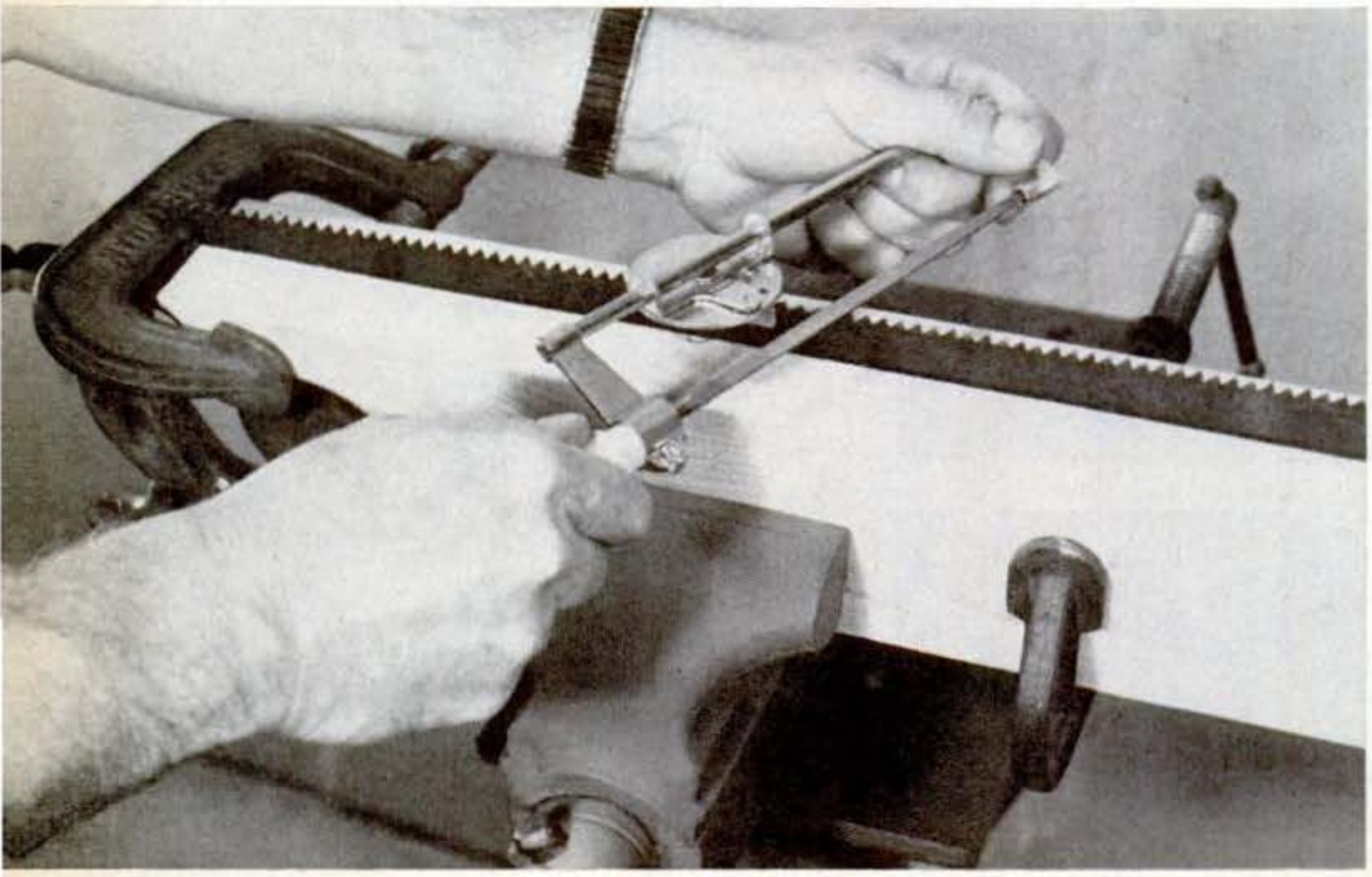


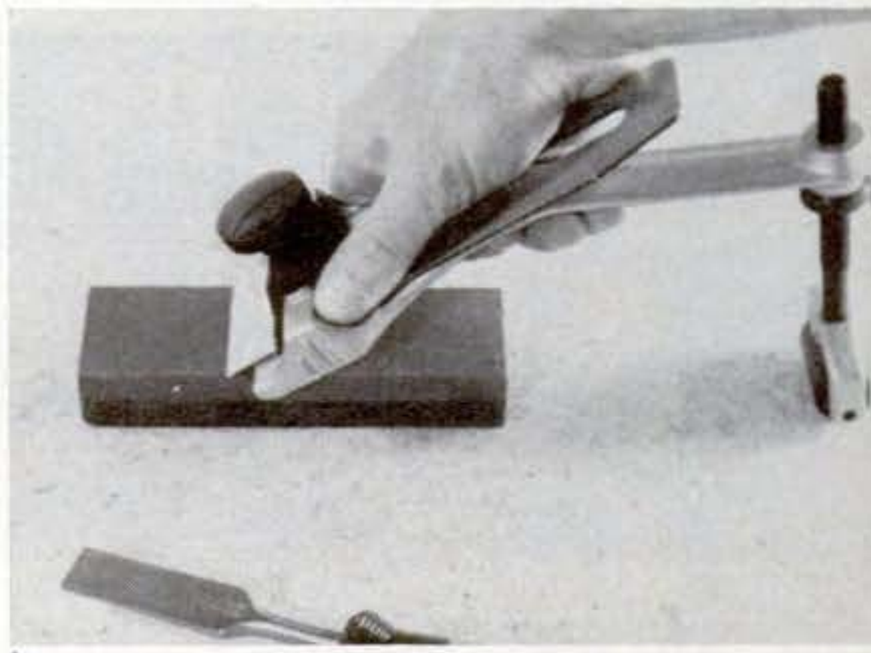
Knob-traversed universal jig is from Sears (catalog no. 19495), has hardware that fits many bench grinders. Hold-down clamp is notched for small tools. $15.



Plane-blade grinding jig by Stanley can also take other tools. The $54 device is designed for the company's own grinders, but can be adapted to others.

Circular-saw filing jig by McBurney will joint and file teeth on most blades from six to 10 in. Switch the bracket guide to file opposite-angle teeth. $9.





Chisel, plane, and screwdriver jig by General has adjustable roller to position tool at proper angle for stone honing. The simple, efficient jig is about $7.

Handsaw-filing jig works best with a full-length clamping device. Detents on the guide position the file at proper angle. Price of the Speed jig is about $4.

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Rowan and Martin explain how the GE Weathertron® Heat Pump can cut your bill for ordinary electric heat 30-60%.*

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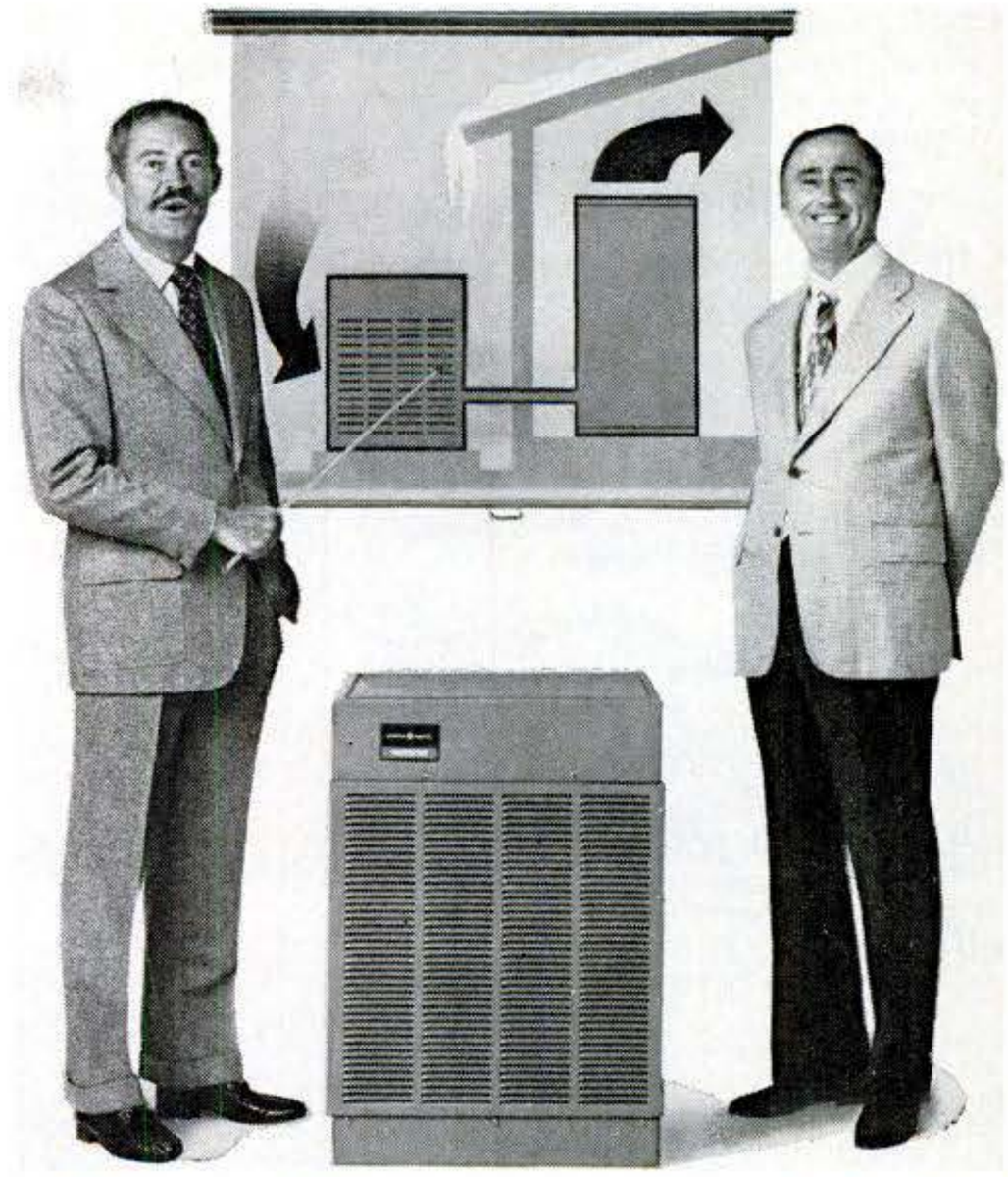
Dick: Like a furnace and an air conditioner in one.



2. Dan: Even on cold days, there's heat in the outside air. The Weathertron extracts this heat and pumps it into the house.
Very often, that's all it takes to heat a house.
Dick: And no gas or oil shortage to worry about.

3. Dan: Then in the summer, it works in reverse—it's an air conditioner—pumps heat from inside the house to the outside.
Dick: Keeps you comfortable all year round.

4. Dan: *Saves you 30-60% on your heating bill—compared to ordinary electric heating, depending on where you live.
Dick: Makes perfect sense to me.

For more information, write to General Electric, Appliance Park, Bldg. 4, Room 206A, Louisville, Ky. 40225.

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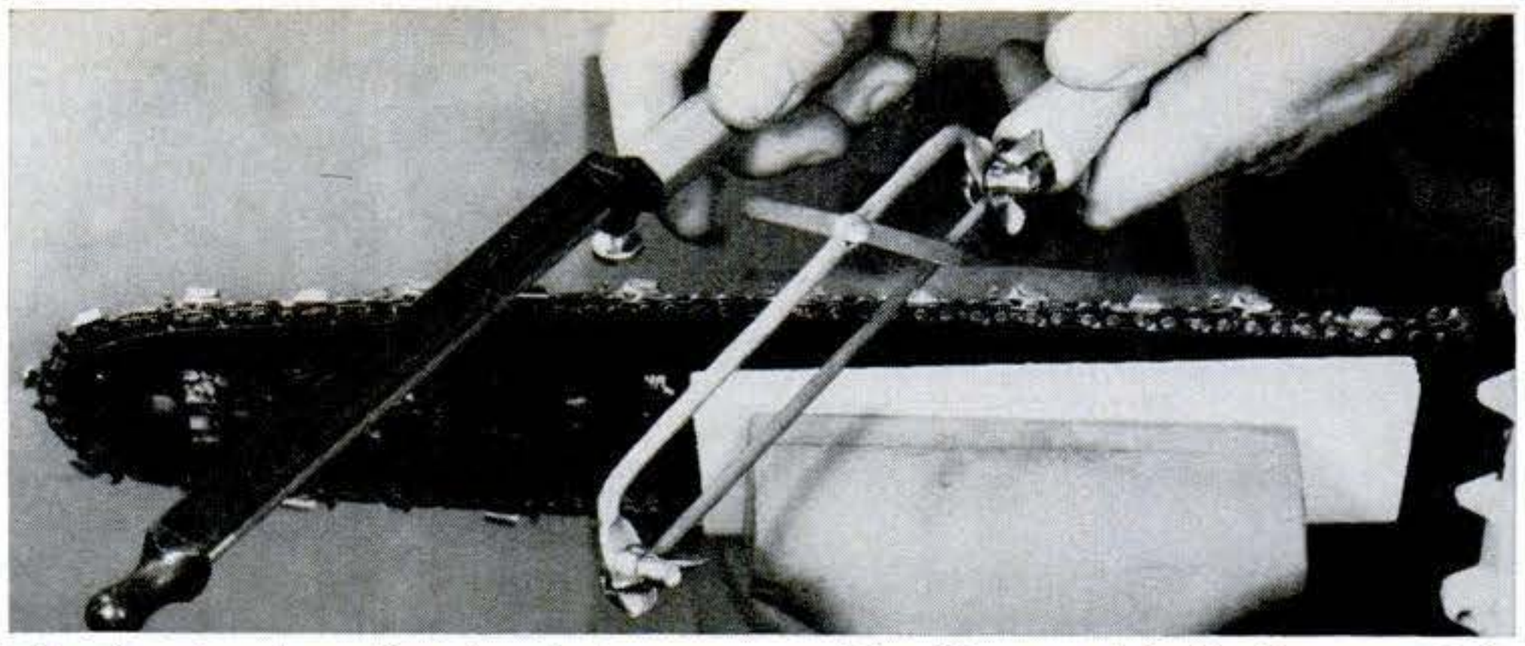
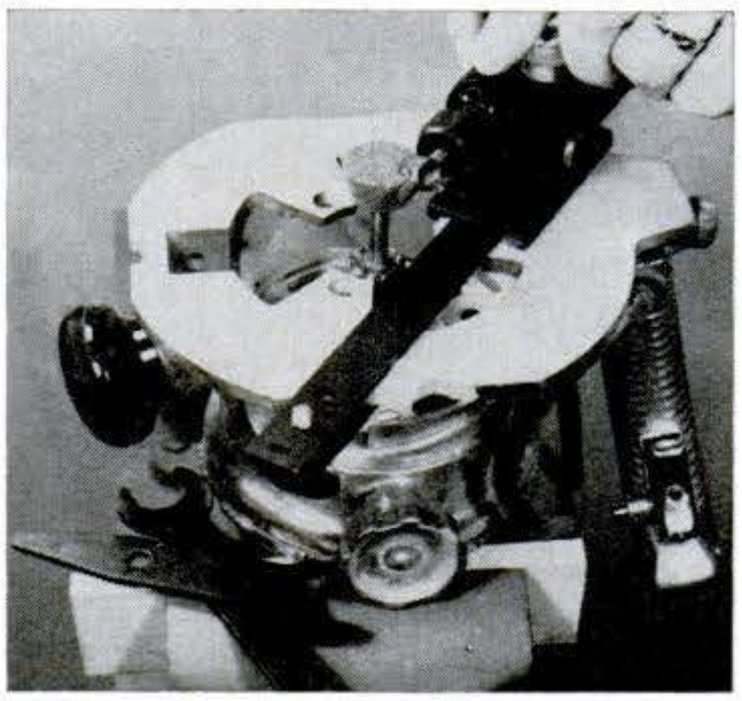
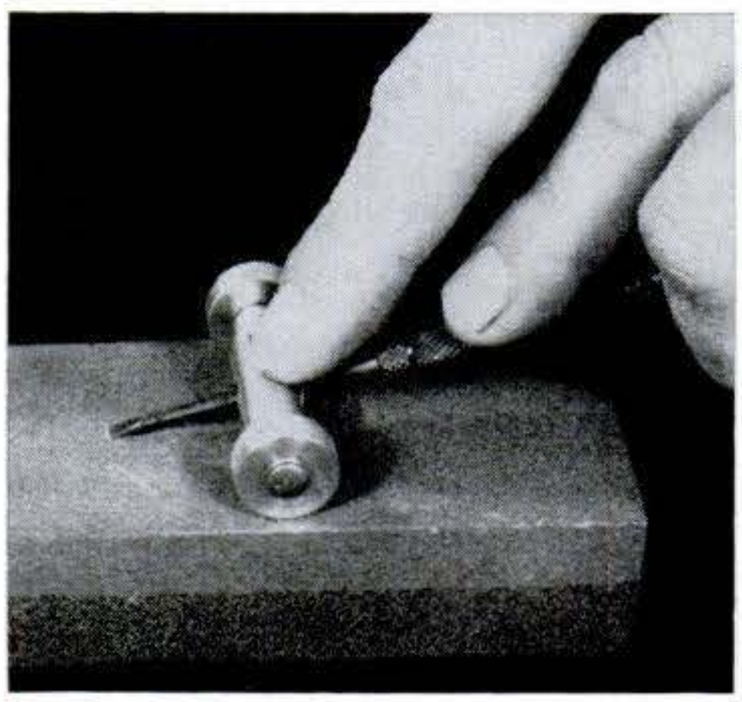


Effective touch-up jigs for chain saws are the Nicholson (left) and Sabre file guides. These and similar jigs cost $3-6, including the file.



Well-made jig for grinding lips of router cutters fits on base. Router motor powers mounted abrasive wheel. Sears unit shown is about $25; Stanley's, $39.



Spring-loaded center tube supports screwdriver blade as you roll it along abrasive stone. The simple jig costs about $5. It's made by National Camera.

ing, I would not recommend a filing jig as a substitute. These simple tools, however, are good for touch-ups. The two shown above, made by Nicholson and Sabre, are simply holders with markers to show you the right angle to file. McCulloch and Pioneer, among others, supply similar tools.

Separate gauges can be purchased to check the depth you file, and filing jigs are also available with integral depth gauges. When purchasing a filing jig, make sure that the file is the correct size.

You can grind the flutes of router cutters with ingeniously designed grinding fixtures from Sears and Stanley. They can be adapted to fit most router bases. The fixture base is fastened to the router base and a mounted abrasive wheel is colleted in the router chuck. The router cutter is held in a collet on a sliding indexing head, which can be raised and lowered very accurately for taking fine passes across the grinding wheel. A spring-loaded detent indexes the cutter to the next flute. These fixtures are capable of doing an excellent regrinding job. Be sure that the grinding wheel is kept dressed and that the same amount of material is taken off each flute. Don't try to hog down each flute. Take a light pass off a flute, index, grind, index, and so on. Then "spark out" each flute in sequence. I didn't try it, but it should be possible to grind carbide-tipped router cutters by replacing the supplied wheel with a silicon-carbide-mounted stone.

The only drawback I can see with the jigs is that you have to tear down the router to grind the cutters. The solution is to have enough cutters on hand. Grind 'em all at once.

The small screwdrivers in your shop must generally be in the best condition, since small screws are usually soft and highly visible. A bad blade can quickly mess up a fine piece of equipment. Hand sharpening small blades is tricky, but the job can be done quickly and well with the simple National Camera jig pictured above. It will take screwdriver blades up to about ¼" in diameter, holding the blade under spring pressure as you roll it back and forth over an abrasive "stone." Grind the other side by simply turning the jig over. Angle is changed by varying the point where the driver is held in the self-centering slot. PS

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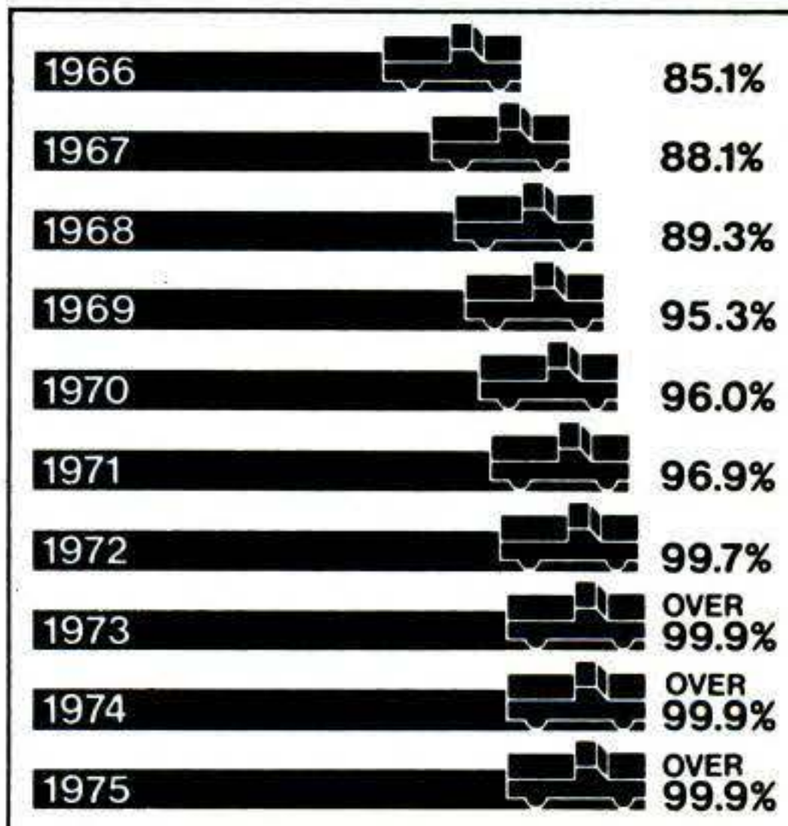
OUR TOUGH CHEVY PICKUP IS A TRUCK WITHIN A TRUCK.

A Chevy pickup is tough in the right places. With two steel walls in the Fleetside tailgate, body sides, doors, front fenders and hood. Plus extensive rust protection throughout.



Chevy has an impressive record for building trucks that last. The chart above shows the percentage still in use in each of the 10 most recent model years recorded. 96% of all Chevy trucks registered during those model years were still in use on July 1, 1975 as reported by R. L. Polk & Co.

Cargo box has a full inner wall of steel extending all the way up the body side on Fleetside pickups. It protects the outer wall from dents.

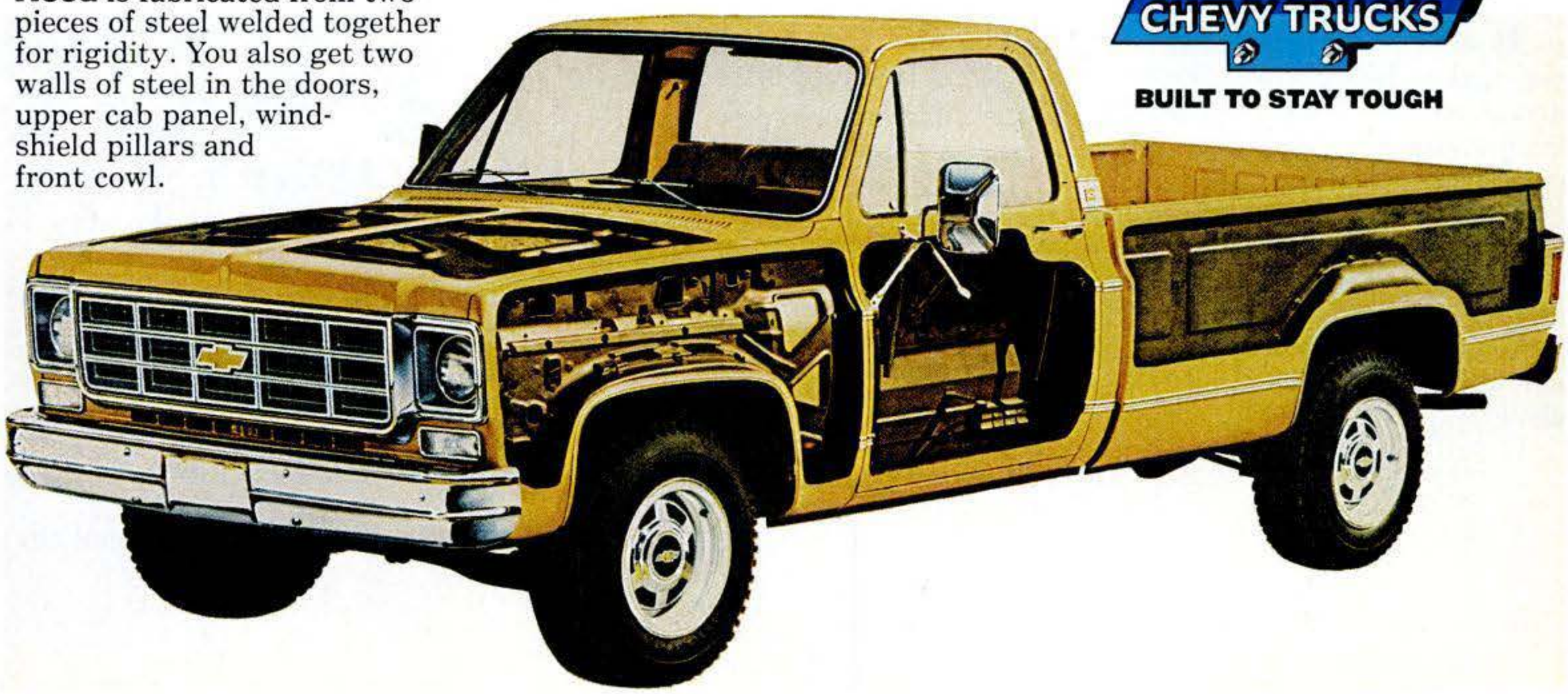
Front fenders have an embossed inner wall of steel under the exterior sheet metal. Plus a self-washing inner fender skirt to help protect engine compartment from salt spray and flying stones.

Hood is fabricated from two pieces of steel welded together for rigidity. You also get two walls of steel in the doors, upper cab panel, windshield pillars and front cowl.

For protection against rust, inner surfaces of both inner and outer front fenders are sprayed with a zinc-rich primer before assembly and final priming. And pickup box steel floor, sidewalls, front panel and tailgate are totally immersed in an electrically charged primer, drawing paint into seams and crevices for corrosion protection.

CHEVY TRUCKS

BUILT TO STAY TOUGH



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The Tobacco. "Flavor Packing"™ plus fifteen tobaccos boost taste.

Take the tobacco, for example. Its taste is boosted by a very unique method called "Flavor Packing" which allows us to concentrate a special patented tobacco flavorant in each Decade cigarette.

The Filter. Unique "Taste Channel" gives first puff impact.

Our filtration process is also unique. Simply, we've created a "Taste Channel" within the filter to give you that first puff impact you've come to expect from only the higher 'tar' cigarettes.

The Paper. High porosity paper controls burn rate.

Even our high porosity paper is specifically designed to give an efficient burn rate that delivers optimum taste with a minimum of 'tar.'

The result. A completely new kind of low 'tar' cigarette.

So try a pack of Decade for yourself. Regular or Menthol. And after one taste we think you'll agree that our last 10 years were well worth the effort.

Only 5 mg. 'tar.'

Regular and Menthol.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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5 mg. "tar", 0.5 mg. nicotine ave. per cigarette by FTC method.

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Popular Science

PS | What's News

In principle, there is nothing new about the water wheel shown in our cover painting this month. The basic engineering design of the Pelton wheel had reached a high degree of sophistication by 1900. Small-scale water power was widely used around the turn of the century. But with the spread of the electric grids and cheap electricity, on-site water power was forgotten and the necessary machinery disappeared from the market, until recently. Now it is making a comeback. Back in 1947, PS ran a classic five-part series on water power for home use that has been widely reprinted in a variety of publications. The surge of reader interest has been phenomenal. The missing information, though, was where to buy the needed equipment. We assigned Engineering Editor Al Lindsley to find out. He spent about a year writing letters and traveling around the country to see what was happening. He found that the availability of the tiny turbines was only part of the story. Water-power enthusiasts are now drawing on much advanced technology to make this alternate energy source more practical: Gemini converters, improved alternators, deep-discharge batteries, solid-state inverters, inexpensive plastic pipe. None of this eliminates the need for a water source, of course. You can read all about it—an update on the new equipment and where to buy it, plus what you need to know in order to evaluate the potential of your own water source, beginning on page 87.

RV no-parking law unconstitutional

The U.S. Supreme Court has refused to review the so-called "Euclid" case, which had been appealed from the Ohio Supreme Court. The Ohio court decision stipulates that it is unconstitutional for a municipality to regulate the parking of recreational vehicles only. A Euclid, Ohio, ordinance, passed several years ago, placed severe restriction on the homeowner's right to store a recreational vehicle on his property, and made it a misdemeanor crime to do so. The effect of the Supreme Court ruling is to establish a precedent that should benefit RV owners in all communities where such ordinances have been proposed or put into effect.

New wood-preserving process

A nontoxic process for treating wood that alters the chemical structure so that the wood won't serve as a meal for fungi or termites has been patented by two scientists of the Forest Products Laboratory. The substance used, an *epoxide* that reacts quickly with wood and leaves no by-product, becomes integral with the wood cell wall. The treated wood actually increases slightly in volume, and won't change shape and size if it gets wet and dries. Treatment takes about 30 minutes. The color of the wood is not changed significantly by the treatment, and the grain retains its natural beauty. For further information, write to Forest Products Laboratory, Dept. NO-TOX, Box 5130, Madison, Wis. 53705.

New solar bulletin

Applications of Solar Energy for Heating and Cooling, a 200-page volume published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), offers a series of technical treatments needed in the design and engineering of low-temperature solar-energy applications. The book (GRP 170) is available through ASHRAE, Publication Sales Dept., United Engineering Center, 345 E. 47th St., New York 10017.

Energy jobs

A new job-placement service intended to bring together energy experts and energy-involved companies has opened at the Institute of Energy Resource Management at Eastern Illinois University. If you have a related background in engineering, environmental sciences, applied social sciences, resource planning and development, or management, and want to make a greater contribution toward solving our energy problems, you are encouraged to submit your resume. For more information, write to the institute at Blair Hall 101, Charleston, Ill. 61920; or phone 217-581-2527.

Consumer-action panels

Have you heard about CAP's—Consumer Action Panels? They can help you if you have a complaint about a car, furniture, or major appliance. The panels are intended to resolve problems when you cannot reach a satisfactory solution by going back to the dealer or the manufacturer. If you have a furniture complaint, contact the FICAP office—Nancy High, Executive Director, Box 951, High Point, N.C. 27261. If a major appliance is your problem, write to MACAP, Virginia Habeeb, Chairman, 20 North Wacker Dr., Chicago Ill. 60606. There are 18 AUTOCAPS across the country. Check with your local Chamber of Commerce or Better Business Bureau to find one near you.

Save $'s as well as energy

Here's a fascinating idea from some innovative bankers in Seattle: They'll lend you money at a lower interest rate if you are buying an energy-efficient home, are making energy-conserving home improvements, buying a car that gets 25 mpg or more, or buying a sailboat. For example, home improvements incorporating good insulation practices qualify for 8.75 percent loans versus the 10.5 to 12 percent charged by other banks in the area. The bankers say the program is based on sound business principles because people who are conservation-conscious tend to repay their loans promptly. This great idea should spread across the country. Start talking it up with your local banker.

New metric tire specs

The next time you buy new tires for your car, you may find the labeling on the sidewalls a bit puzzling. With the new metric tire-size designations just issued by the U.S. Department of Transportation, you'll see inflation pressures expressed in kilopascals (kPa) and load ratings given in kilograms. The tires will be required to meet the same level of safety performance as existing tires. DOT's National Highway Traffic Safety Administration said issuance of the new metric tire specifications is consistent with a worldwide effort at standardization of tire designations.

Hubert P. Luckett
Editor-in-Chief

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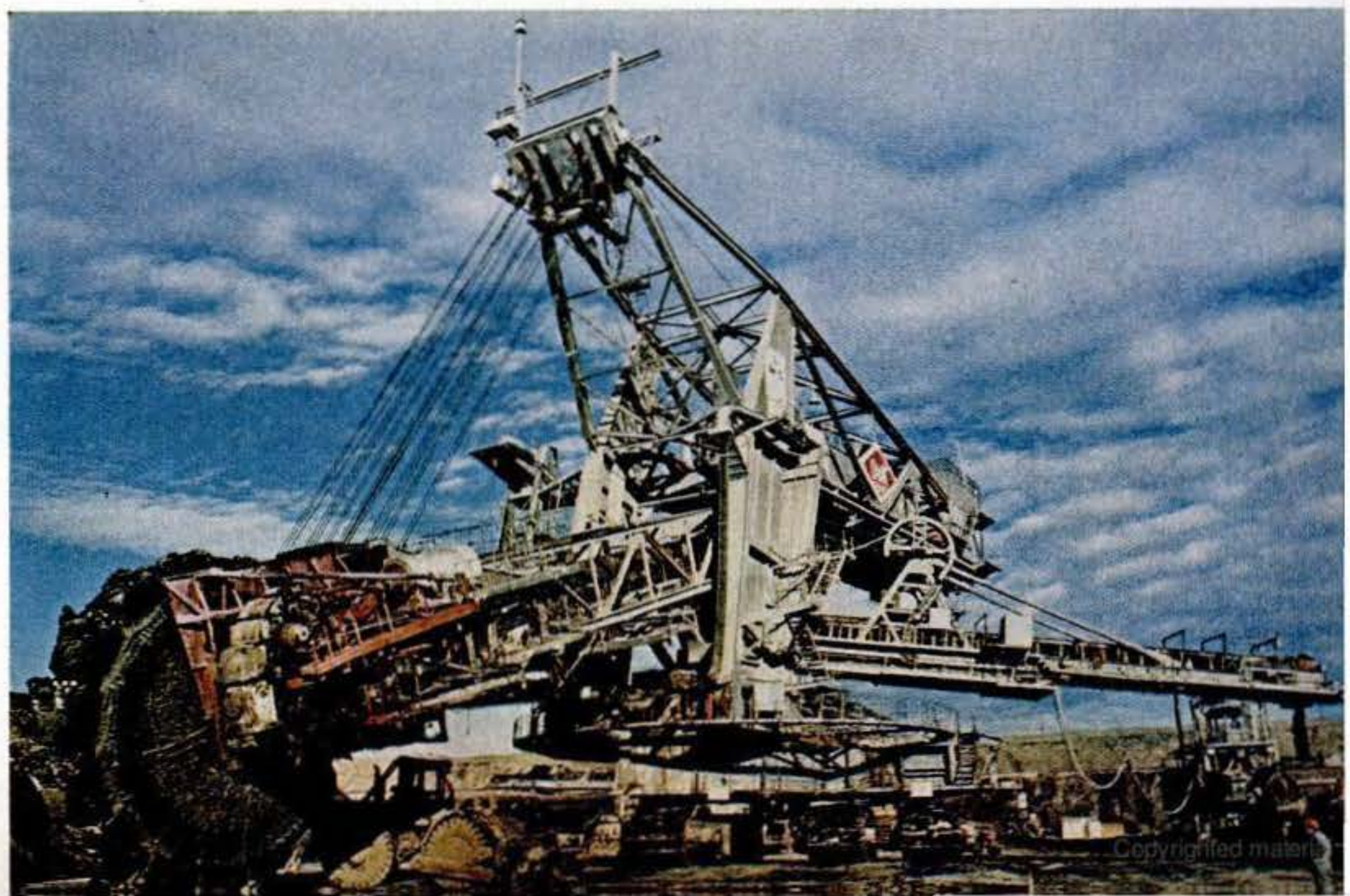
How they're extracting oil from tar sands

Viscous bitumen (inset) separated from tar sands is shoveled from a jar with a stirring rod. The thick substance must be "cracked" by baking it to eliminate excess carbon; gases formed are converted into naphtha, kerosene, and gas oil. The twin reactors above, part of Syncrude's sprawling mining and extraction operation being built in Alberta, Canada, were imported from Italy. Moving one by road took a 144-wheel truck; moving another by rail took two special 12-wheel flatcars. The remoteness of the mining site and the difficulty of supplying the wilderness operation with equipment and crews contribute to steep costs. At right, a bucket-wheel excavator scoops up tar sand at GCOS site and dumps it onto a seven-mile-long conveyor belt.



A 30,000-square-mile layer of tar and sand in Canada is being tapped by large-scale processing plants

By CHARLES E. MAURER

FORT MCMURRAY, ALBERTA

I looked around from a catwalk four stories up and saw barrels bigger than boxcars revolving around my head. Steam whooshed and billowed from a maze of enormous pipes nearby; behind me, a black broth bubbled in cauldrons as big as my house. The air reeked of tar. And every pipe, motor, and machine, every square foot of floor and stair, was coated with a thick, black goo.

Near the ground, dirt and sand were mixed with the goo, which had hardened into a dead ringer for asphalt paving. Up in the clouds of steam where I stood, it felt soft. On warm machines it flowed slowly, like molasses.

"Not very pretty, is it?" my guide yelled into my ear. "But we have a saying: 'Where there's muck, there's money!' "

Canadians today hope that's true, for here, halfway between Montana and the Arctic Circle, there's more muck than anywhere else in the world. Fly over it, and all you see below is muskeg swamp. Dig underground anywhere in a 30,000-square-mile area, and you'll find that black, gooey tar mixed with sand.

Tar sand, they call it. Or oil sand, because in plants like the one I visited, tar can be extracted and converted into oil—potentially five times more oil than we know to be available from all the natural deposits in North America.

But to mine the sands and make the oil costs three times more than to pump up natural crude. And to do it even that cheaply takes an operation of monumental size and cost. Great Canadian Oil Sands (GCOS), a subsidiary of Sun Oil, has poured over $400 million into the 10-year-old pioneering project I toured. Sprawling over 8.5 square miles, it produces 50,000 barrels of oil per day, as much as a respectable refinery merely processes.

Yet GCOS is just a pilot compared to Syncrude, a new project of three oil companies and three

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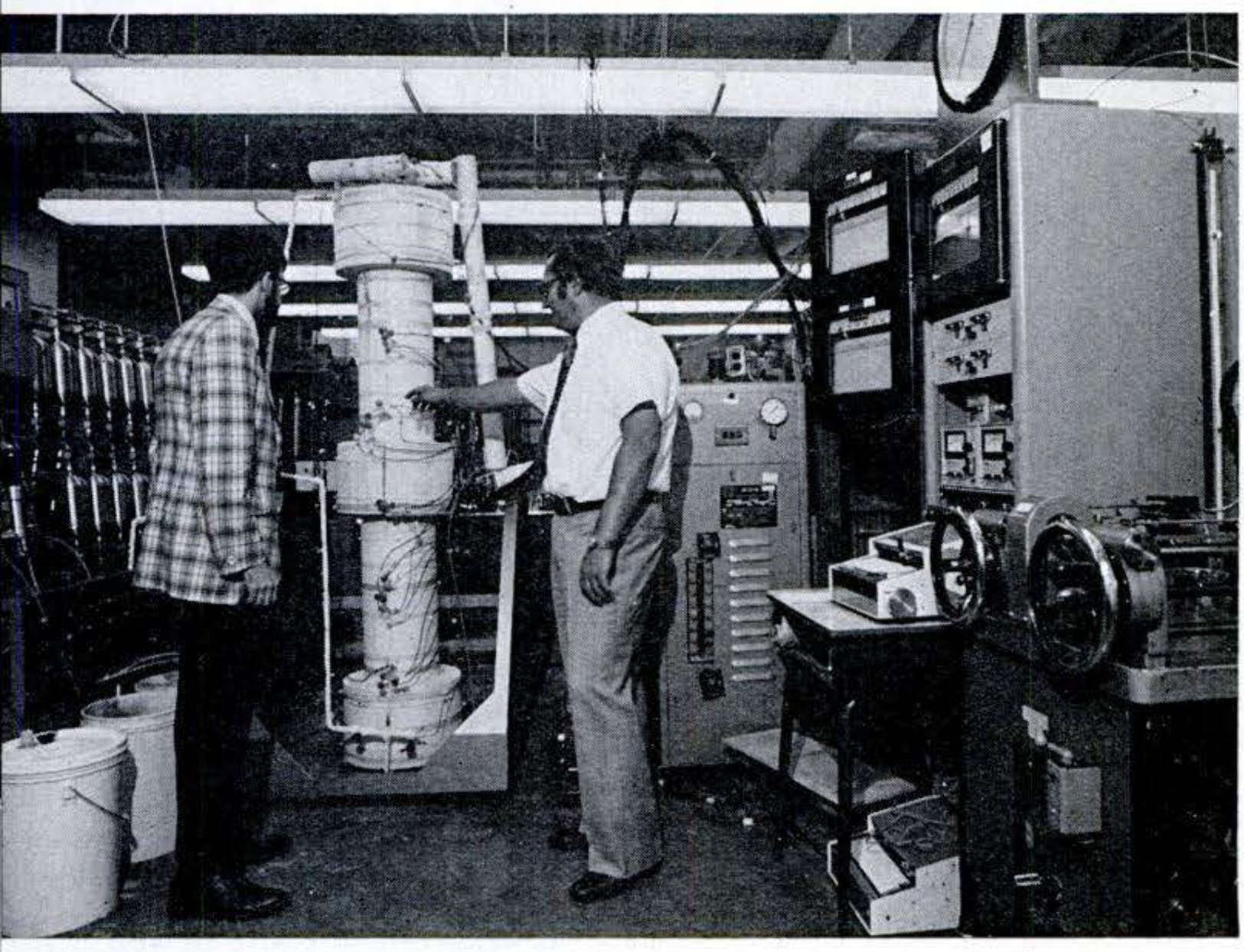

Steam-injection process for extracting bitumen from tar-sand wells is under study in a lab by Dr. Donald Flock, who points out a sand container to author.

Tar sand is dark gray, sticky, and glistens in the sun. Huge Canadian deposits contain more oil than North America's natural oil deposits.

Six-foot-wide conveyor moves tar sands at 15 mph from mining sites to the extraction plant. GCOS project produces 50,000 barrels of oil per day.

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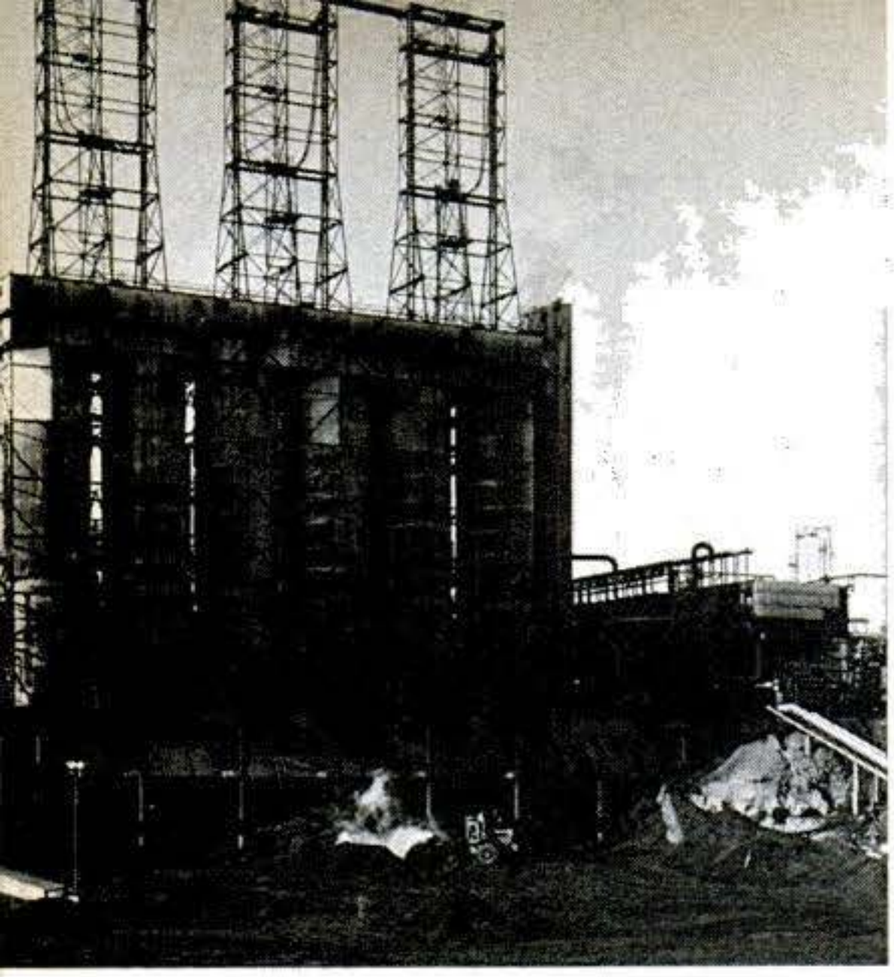
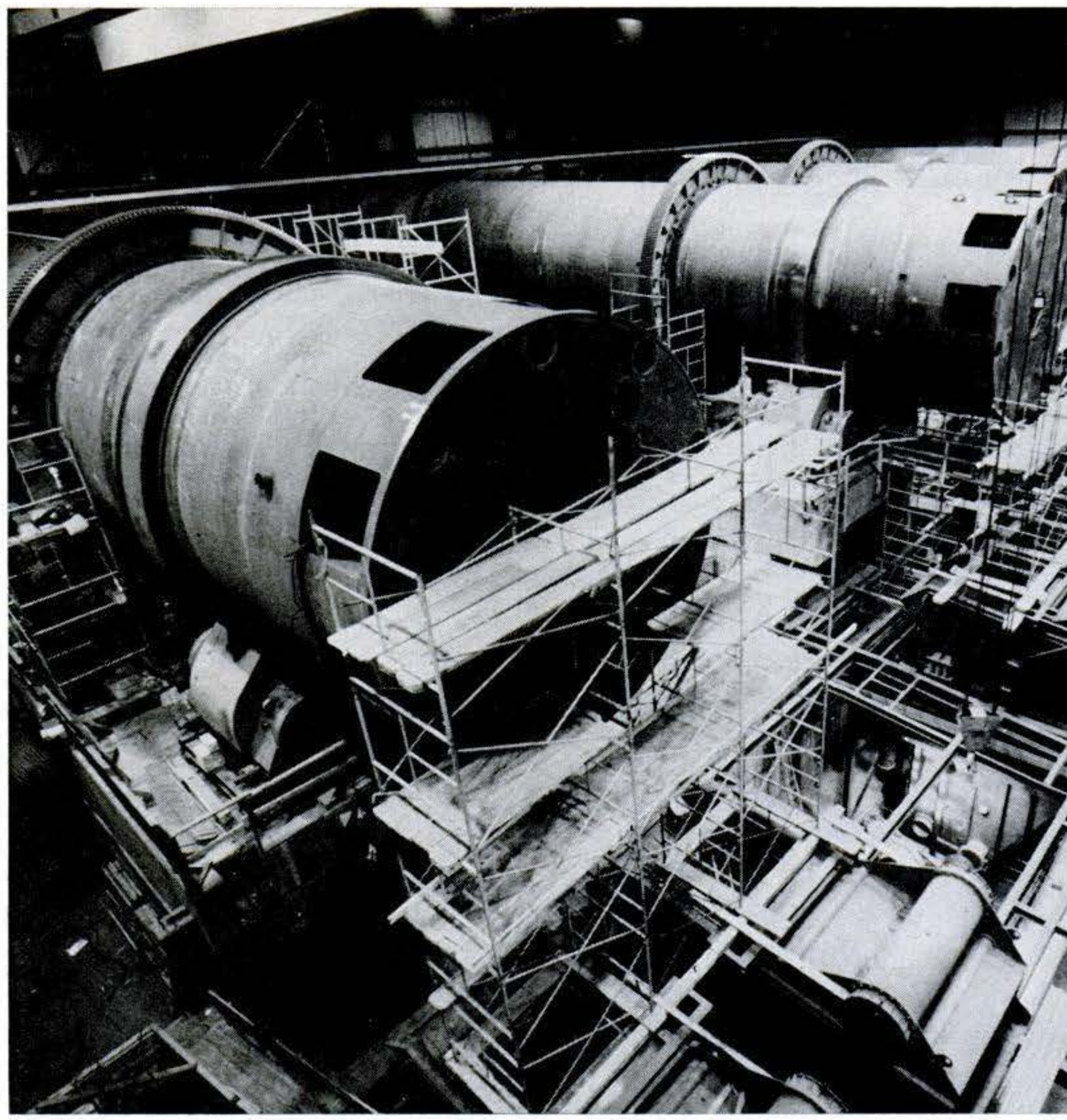


Sea of ash produced by GCOS cokers (top) is spread around still smoking. Some 2000 tons per day are burned by the plant's powerhouse. Above is the base of one of Syncrude's four giant draglines. When completed, the 10-story, movable structures will excavate 80 cubic yards with one swipe.



Four tumblers in Syncrude's extraction plant (over 60 percent complete) revolve to mix tar sand with hot water and steam. The process produces bitumen, sand, and clay. Oil-rich bitumen is then separated from the slurry.

Canadian governments. Syncrude could swallow up all of GCOS with nearly enough room left over for Manhattan Island. When it's finished next year, it will have cost $2.3 billion. After a few years of "de-bottlenecking," it should produce 125,000 barrels every day.

When Syncrude starts up, oil from the tar sands will become the first "exotic" oil to pour through pipelines in large quantity. But it will be a dribble compared to the millions of barrels we use every day. How much more can we realistically expect to get from the sands, and when? POPULAR SCIENCE sent me here to find out.

Processing headaches

On my way, I stopped at the University of Alberta in Edmonton to see Dr. Donald L. Flock, a professor of petroleum engineering who specializes in tar sands. The sands, Flock said, came from a deposit of ordinary oil that once lay beneath an ancient sea. Long ago, the land rose and the water disappeared. With no more surface pressure to hold the oil down, it migrated upward into the still-wet floor of the sea.

"As you can imagine," Flock said, "the floor was very varied, with many different kinds and sizes of sand and rock. In some places there was a lot of oil, in other places only a little. As a result, the mixture was very heterogeneous—and it still is. Shovelsful dug up 50 feet apart can look as if they came from five miles away. When engineers try to process the stuff uniformly, it doesn't give them headaches—it gives them migraines."

Because the sea floor was still wet, a film of water and seashore clays separated each grain of sand from the oil. Explained Flock, "Since it was covered by oil, the water never evaporated. Today it lets us remove the oil from the sand just by applying hot water and steam."

On the other hand, the oil is no longer oil. "Sitting out there in the sun, the lighter hydrocarbons evaporated. All that's left are the heavy, carbon-rich hydrocarbons, plus the sulfur and other impurities. They make up the tar, which is really a form of bitumen."

Since then the eons have dumped up to 2500 feet of boulders, gravel, sand, clay, and rotting, fetid muskeg atop the sands. But the tar sands still lie there in four major deposits, in a layer 100 to 150 feet thick.

Geologists once believed there was loose oil underneath, until 70 years ago when entrepreneurs like German Count von Hammerstein (properly attired in buckskins, a kerchief, and a Teddy Roosevelt hat) blew both a fortune and the idea by drilling wells. All they found was salt.

Clark process

First to work out a practical application was Dr. Karl A. Clark, a government scientist. He spent 30 years developing a way to extract the bitumen so it could be turned into oil. In the late 1940's, he

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Muck into money: how an oil mine works

A sopping mat of rotting roots and leaves five to 20 feet thick, topped by scraggly spruce and tamarack trees—that's the muskeg that covers this country. It must come off first; yet in summer it's too soggy to support heavy machinery, and in winter its frozen crust is usually too thin. Crews can work on it only in the coldest part of winter, when the temperature is often 30 to 40 below.

Next to be stripped is the overburden: up to 150 feet of clay, sand, gravel, and boulders (all of which, by law, must be put back). GCOS uses seven front-end loaders, each of which could fill 5.5 pickup trucks with one scoopful; 26 dump trucks, each 22 feet *wide*; and a bucket-wheel excavator—a block-long monster that can dig an average of 1.5 tons of sand and rock per second.

Now the tar sand is exposed. Two tons of it must come up (and must eventually be replaced) to make one barrel of oil. GCOS mines it with two large bucket-wheelers plus a smaller one. Syncrude will use four large bucket-wheelers, but not to mine; they'll be used to pick up windrows left by the four 6500-ton draglines described in the story.

Mining goes on nonstop throughout the day and year—unless the temperature drops near 50 below, when machines become too brittle. Lynda Costello, public-affairs coordinator and my guide at GCOS, described the operation to me: "In winter, a frozen face of tar sand is like a wall of granite. Trying to dig it, we've had buckets of 1.25-inch-thick steel plate rip like orange peels. Nowadays we fluff up the sand first by blasting, but the first year we didn't. Then a bucket-wheel had 120 teeth, each weighing about 100 pounds. At night they'd glow red, and we'd wear out a whole set in one shift."

From the mine, the tar sand travels by conveyor into an extraction plant. Here, revolving drums (in Syncrude's case, four of them 100 feet long) mix oil sand with an equal amount of 185°F water, plus live steam and a little caustic soda. In a few minutes the tar sand disintegrates into bitumen, sand, and clay.

But it's all mixed together in a slurry of water. To remove the bitumen, the slurry is pumped into four extraction tanks or separation cells—soup kettles several stories high and, in Syncrude's plant, 62 feet across. There most of the sand settles to the bottom, and most of the bitumen rises to the top in a black froth. Paddles skim off the froth, and the water underneath goes to a second set of tanks, where air pumped through carries additional bitumen to the surface.

This collects virtually all the bitumen, but the bitumen still contains about 35 percent water and minerals. So it's thinned with naphtha and twirled in centrifuges. The naphtha is boiled out, and pure bitumen is left—a pitch-black liquid so thick I saw a chemist in a warm lab dig it out of a bottle with a stirring rod, in hunks.

Now comes the major step in upgrading: removing excess carbon. GCOS bakes the bitumen for hours at 900°F until it "cracks" into coke and several gases. The gases are drawn off the top, and the coke is swept out the bottom, still smoking.

This works, but each batch takes seven hours, plus a lot of cleaning up. To speed things up, Syncrude is going to try a continuous process that's recently been developed for refining heavy oils. Instead of baking the bitumen, Syncrude will heat it to 500°F, then spray it into a skyscraper of a tank charged with very fine particles of 900°F coke suspended in the air. The bitumen cracks when it contacts the coke, forms more hot coke, and the process continues. This should give better efficiency, but no one has ever tried it on Syncrude's scale.

From here on, an oil mine works like an ordinary refinery. Some light process gases are chemically scrubbed free of sulfur, then either burned in the plant's powerhouse or used to make hydrogen for purifying the heavier gases, which at GCOS are separated into naphtha, kerosene, and gas oil.

"The naphtha we come out with you could probably burn in your car as gas," said John Perehinec, manager of public affairs. "The kerosene is just a step or two away from meeting the international specs for jet fuel. But they aren't quite finished products; we can't economically finish refining them here. We do keep out some stuff that meets the railroads' specs for diesel locomotive fuel, but everything else we blend back together and pipe out as 'synthetic crude.' "

Of course, the "synthetic crude" is not very crude. It looks and feels like 5W motor oil, and is, say, 80 percent refined. Refineries aren't built to handle just the last 20 percent of a process, so they put it through from the beginning—usually mixed with thick natural crudes to increase the amount of gasoline.

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proved his process in a pilot plant built by the government of Alberta. Syncrude is going to use Clark's process, and GCOS is using it today (see full details in box above).

It works well, but it's mighty expensive. GCOS has shown a profit only two years, and has accumulated $80 million in deficits. The company has had many start-up and operating woes, and large as it is, it's found itself inefficiently small. Said Bill Oliver, director of corporate affairs, "Future plants will probably be 2.5 to five or more times larger than ours."

A 2.5-times-larger Syncrude means a plant mammoth enough to extract the bitumen from three tons of tar sand every second of the day throughout the year. And upgrading the bitumen will require a second plant that by itself will be larger than most refineries. And an open-pit mining operation to dig out the sands will . . . well, let me tell you about the dragline I saw being assembled.

One swoop, 80 cubic yards

Its parts had been delivered in the equivalent of 175 railroad cars. After eight months of work, when I saw it, it was a mass of steel plate the size of a department store. "And that's just the base," explained Dar Tost, my guide from public affairs. "Just the part that walks. The house and structure on top will be 10 stories high, with a 360-foot boom sticking out. The bucket will dig out 80 cubic yards with one swipe, enough to fill a two-car garage. And we're going to have four of them working at once."

A plant like Syncrude can recover about 65 percent of the oil locked up in the sands, more than double the percentage pumped out of most conventional deposits. But it works only when the sands are accessible, which limits development for now.

Flock explained the problem to me: "Strip mining is feasible only where the overburden is less than 150 feet thick, and that's true for less than 10 percent of the tar sands. It's too expensive to mine the rest conventionally, underground. For 90 percent of the tar sands, operations like Syncrude won't work at all."

Bacterial mining?

"With the deposits between 150 and 700 feet down, nothing else works either, as of now. You can't use any process involving high pressure, like pumping in steam, because the overburden isn't thick enough to withstand it. All you can do, maybe, is break down the bitumen underground with electricity or bacteria or chemicals. Or possibly mine it using some elegant, untried techniques. People are working on the problem, but at the moment those deposits are an unknown zone, a no-man's-land.

"On the other hand, the reserves deeper than 700 feet—about two-thirds of all the reserves—are very promising. There the overburden is thick enough that you can use two

[Continued on page 170]

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40-channel CB's

–lots of new choices

Sparkomatic CB 3040 has a memory: It will store any channel you wish for instant selection; just hit a recall button. Up/down buttons select channel, and indicators show status of rig. $179.95. Sparkomatic, Milford, Pa. 18337.

Courier Rebel 40 offers 40-channel operation but at a low price—$109.95. Rig has S/RF meter and public address capability. Fanon Courier, 990 Fair Oaks Ave., Pasadena, Calif. 91105.

Hy-Gain 9 unit has all the works in its mike. Volume, squelch, or channel changes are done with built-in controls. Black box mounts in trunk. $239.95. Hy-Gain, Box 5579, Lincoln, Neb. 68505.

Super Tiger 40 has switchable noise limiter and blanker circuits in addition to RF gain control. $229.95 buys it. Pearce-Simpson, 4701 N.W. 77th St., Miami, Fla. 33166.

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Better performance, more features, and 17 extra channels on these new rigs

By HERB FRIEDMAN

After years of predictions and guesses, they're here: the 40-channel CB rigs. Some 150 models have been type-approved—just a few are shown here—with more to come. And there are surprises.

The list of convenience features appears almost endless. More metering is in evidence, for one: The common S/RF meter is now accompanied in the higher-priced models by an SWR (standing wave ratio) or a modulation meter. The typical channel selector is still the multiposition rotary switch. On some models, the channel number is indicated directly on the knob, but others have LED electronic displays—in half-inch digits. But, because the LED is small and so easy to see, many rigs are also available with some controls built into the microphone to permit one-hand operation. These include up-down channel-selector button, and volume and squelch controls. The main electronics package neatly tucks into a black box under the car's dashboard for protection against theft.

Scanner models automatically scan up to three channels: 9, 19, and one that's been preselected. Such sets lock onto the first signal received and automatically indicate the channel number. For boating, there's a CB transceiver with a built-in monitor for the national VHF weather frequencies. For the camper vehicle, there's a model with a built-in intercom that can

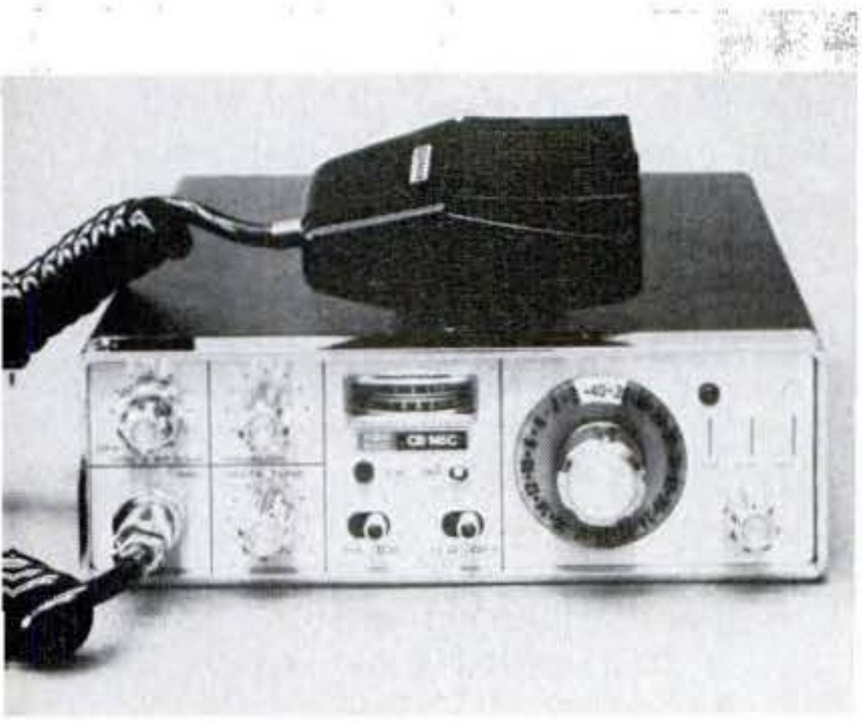
Continued

The built-in side brackets on the Craig L-101 allow easy removal. Seven-segment incandescent displays indicate the channels. Craig Corp., 921 W. Artesia Blvd., Compton, Calif. 90220. $169.95.

In-dash model from Panasonic doubles as an AM/FM radio with built-in 40-channel CB. Also, you can monitor CB while listening to music. Model CR-B4747 is $300. Panasonic, One Panasonic Way, Secaucus, N.J. 07094.

Base station from Cobra operates on AM single sideband. A 24-hour digital clock turns unit on or off automatically Price: $519.95 for this 135 XLR model. Made by Cobra, Div. of Dynascan, 6460 W. Cortland St., Chicago 60635.

Lafayette's model HB 740 transceiver has blanker, limiter, delta-tune, S/RF meter, and a new kind of warranty. The set's guaranteed for as long as you own your car. Price is $159.95 from Lafayette, 111 Jericho Tpk., Syosset, N.Y. 11791.



You can tune in either of two weather bands as well as all 40 channels with this Pace CB 145C. It's $249.95. Pathcom, 24049 S. Frampton Ave., Harbor City, Calif. 90710 .

Strap the battery pack to this mobile Midland 77861 rig and it becomes a powerful hand-held unit. It's $207.95. Midland International Corp., Box 19032, Kansas City, Mo. 64141.

"Extended" button on this new Motorola 4020 rig acts like a noise blanker to eliminate outside interference. $259.95 from Motorola, 1299 E. Algonquin Rd., Schaumburg, Ill. 60196.

Indicator lights on this GE 3-5812 show the status of audio and antenna. It has noise-limiting control, too. Made by GE's Audio Electronic Products, Syracuse, N.Y. 13201. Price: $174.95.

Channel selector, volume, and squelch controls are all on the mike of this RCA 14T410; channel readout is on the set. The $209.95 rig is from RCA's Special Products Div., Deptford, N.J. 08101.

Lift the handset of this E. F. Johnson model 4250 base rig and the speaker quiets for private listening without bothering others. E. F. Johnson, 299 10th Ave., Waseca, Minn. 56093. $259.95.

Tram's SSB rig has mike gain, RF gain, PA, and built-in SWR bridge with meter. LED's display the channel. Tram/Diamond, Lower Bay Rd., Box 187, Winnisquam, N.H. 03289. It's $450.

Realistic TRC-452 rig has an RF gain control that prevents receiver overload from nearby transmitters. $139.95 from Radio Shack, 2617 W. Seventh St. Fort Worth, Tex. 76107.

Buttons on the mike of this SBE Touch Com 40 actuate a two-speed up/down channel selector. $259.95. Made by SBE, 220 Airport Blvd., Watsonville, Calif. 95076.

If you like features, try this new single-sideband base station from Royce. Model 1-642 has a button for just about everything. Digital readout displays channel number as well as time. Royce, 1142 Clay St., No. Kansas City, Mo.

be used between pickup cab and slide-in camper.

A complete entertainment center built directly into the dash is possible with the integral AM/FM/cassette/CB transceiver models, and similar units that have eight-track players instead of cassette players.

For those who prefer slide-bracket protection against theft, some of the 40-channel models come with the bracket as part of the cabinet.

Base stations are also available with the same performance and features as mobile models. They generally operate on 13.8 VDC and 120 VAC so they can also be used as mobiles. Depending on the price, the base model might have a digital clock, a headphone jack and possibly an extra meter or two.

Price and performance

Some updated 40-channel transceivers are priced no higher than their 23-channel predecessors. One explanation is that the 23-channel model had been converted to phase-lock loop (PLL) in 1976; only slight circuit changes were needed for 40-channel updating.

More important than price are the surprises in performance. Many of the older 23-channel models claimed to have 100-percent modulation voice limiting; however, a loud voice or misuse of a power mike could cause overmodulation—resulting in splatter distortion, or spillover interference to adjacent channels.

To meet the FCC's type-approval program, the new 40-channel transcievers must have 100-percent "voice limiting." This means that there's some form of power booster in every model since, if the voice level is raised, the modulation must be compressed to maintain the 100-percent specification. This is the same effect you'd get if you were paying extra for an optional compressor-type power microphone.

In many cases, the new 40-channel transceivers will sharply reduce or eliminate interference to nearby television receivers. This is because FCC type-approval now requires a relatively high degree of filtering of the CB transmitter's harmonic-frequency output—those signals that cause interference to TV channels 2 and 5.

And, despite rumors to the contrary, the 40-channel rigs operate at the four-watt limit. All in all, they're excellent quality radios at good prices. PS

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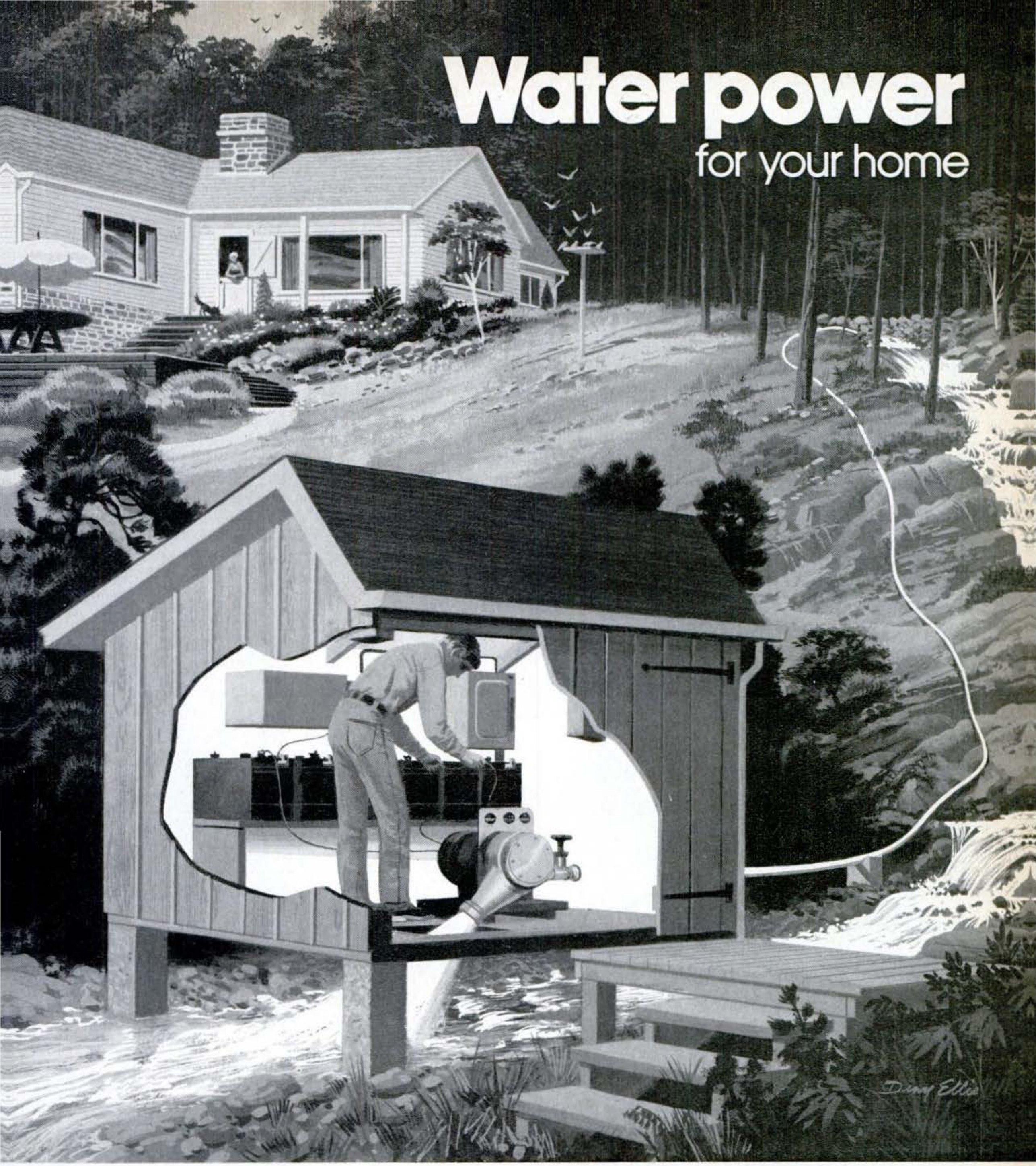
Water power
for your home



Tiny turbines and new electronics make small-scale hydroelectric plants practical

By E. F. LINDSLEY

Today, you can buy exciting new packages of small-scale hydroelectric equipment that make it practical to tap the energy contained in flowing water.

As one outstanding example, picture a 6½-pound turbine, about the size of a shoebox, capable of producing up to 600 watts. The turbine, dubbed Hydromite, is the result of endless hours of research by the late Mike New of Canyon Industries. Incredibly, the tiny turbine's housing is a Y junction from plastic sewer pipe.

While plans to market the Hydromite were incomplete as this issue went to press, the turbine on this month's cover of POPULAR SCIENCE can be purchased

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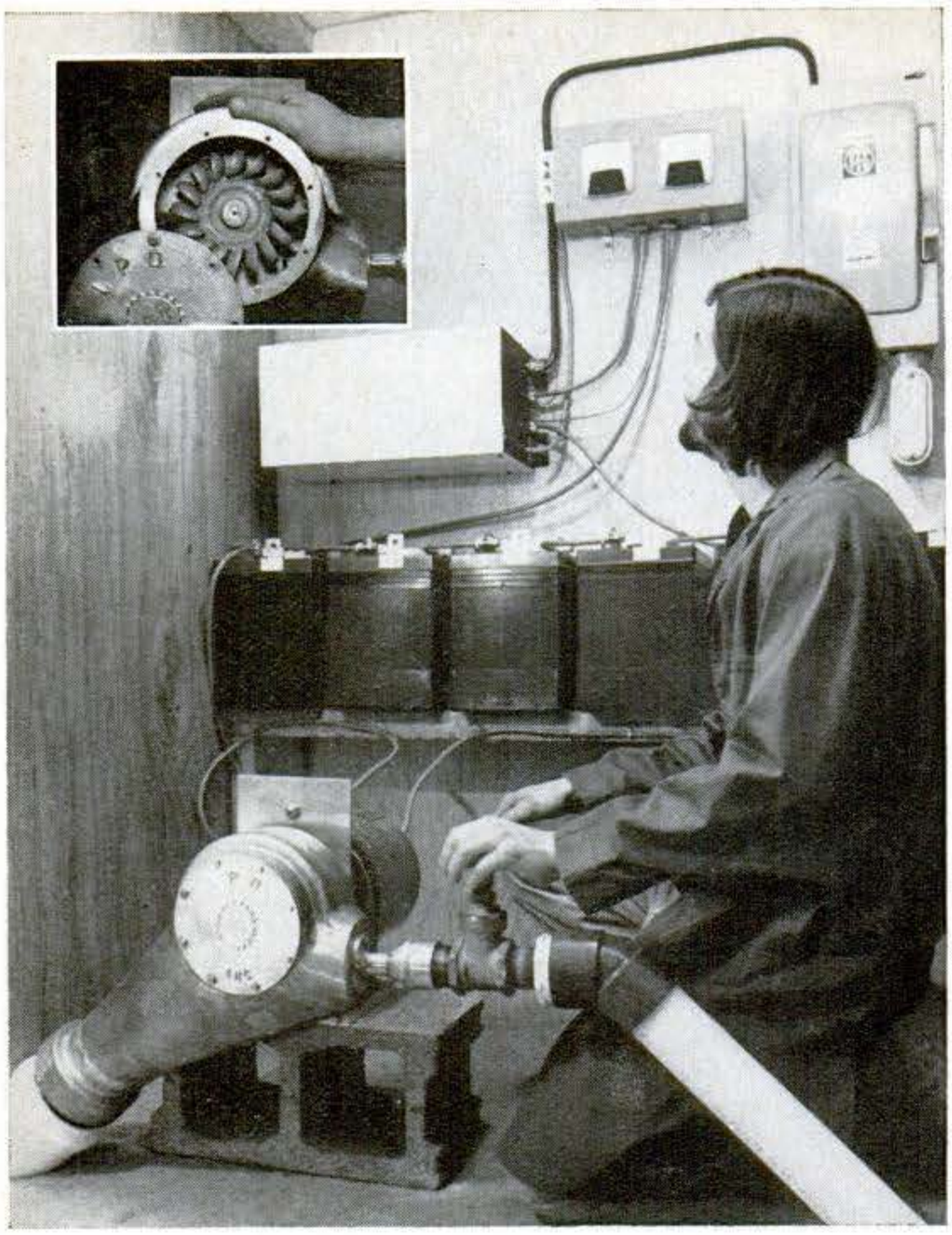

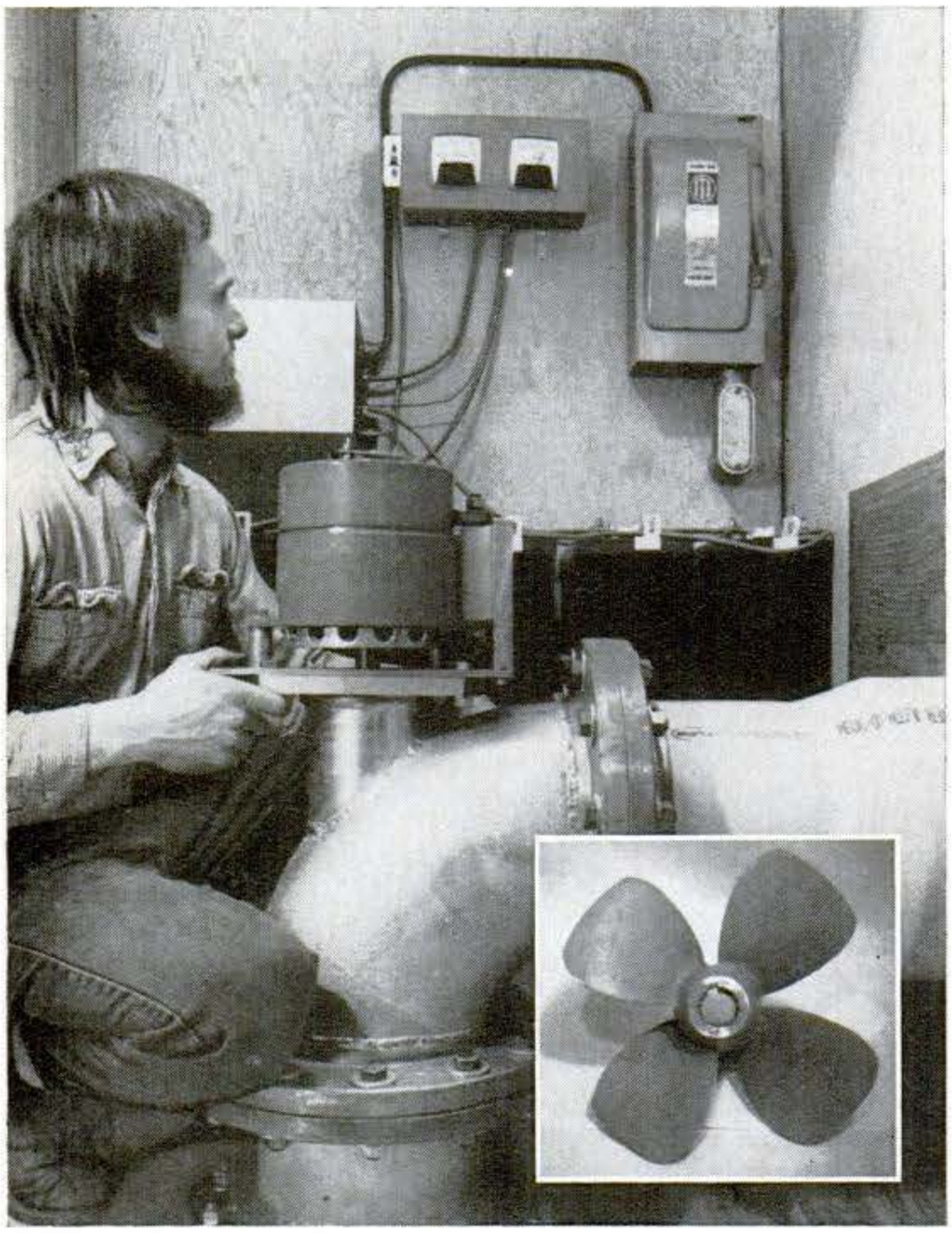

Two tiny turbines: IPD's Pelton wheel (top) has 4" runner (inset), puts out up to two kilowatts (see performance chart). DC alternator charges batteries; inverter (above batteries) changes DC to 115V-AC. Water feeds in through penstock at right, is discharged at left; gate valve controls flow. IPD's Bill Delp recommends reaction turbine (below) for low-head plants. Runner resembles propeller (inset).

and installed today. Created by Bill Delp of Independent Power Developers, the miniature turbine is directly coupled to an alternator. Output of this system ranges up to 2000 watts, or 1500 kwh a month (see performance chart below).

If, instead of IPD's unitized-system approach, you'd prefer to build your own water-power system, there are outfits that will sell you plans and/or parts. I'll tell you more about them later.

New turbines are only part of the story: Small alternators, deep-discharge batteries, solid-state inverters, and Gemini converters are components in the sophisticated technology that's updating this ancient power source.

Of course, the new gear still needs water: You'll need to know how to measure flow rate and determine the "head" or difference in elevation between water source and turbine to estimate the power potential. These factors also largely determine what type of turbine you use. Energy storage is another consideration. Dams were the rule in the past, and even now for large-scale hydroelectric plants. But for small, on-site installations, batteries offer many advantages. Another choice: AC or DC power generation. Which way you go will affect the design of your system.

Performance of IPD's impulse turbine

IPD MODEL 4P SA-32 (4" PELTON RUNNER WITH 1/10" to 4/10" NOZZLE AND 32-VOLT DC ALTERNATOR)

46 feet (20 psi)	Watts					102	126
	Kwh/mo.					74	90
	GPM					15	18
	Pipe diam. (in.)					1.5	1.5
57 feet (25 psi)	Watts		109		150		182
	Kwh/mo.		78		108		131
	GPM		12		17		21
	Pipe diam. (in.)				1.5	1.5	2.0
69 feet (30 psi)	Watts			96	144	198	245
	Kwh/mo.			69	103	143	176
	GPM			9	13	19	23
	Pipe diam. (in.)			1.5	1.5	2.0	2.0
80 feet (35 psi)	Watts			119	178	246	301
	Kwh/mo.			86	128	177	216
	GPM			10	15	20	25
	Pipe diam. (in.)			1.5	1.5	2.0	2.0
92 feet (40 psi)	Watts			143	213	294	357
	Kwh/mo.			103	153	212	257
	GPM			10	15	21	24
	Pipe diam. (in.)			1.5	2.0	2.0	2.0
103 feet (45 psi)	Watts			168	242	343	417
	Kwh/mo.			120	174	247	300
	GPM			11	15	22	27
	Pipe diam. (in.)			1.5	2.0	2.0	2.0
115 feet (50 psi)	Watts		119	200	248	412	497
	Kwh/mo.		86	144	215	296	357
	GPM		8	12	17	24	29
	Pipe diam. (in.)		1.5	1.5	1.5	2.0	2.0
138 feet (60 psi)	Watts	79	157	263	392	539	658
	Kwh/mo.	57	113	190	282	388	473
	GPM	4	8	13	19	26	31
	Pipe diam. (in.)	1.5	1.5	1.5	2.0	2.0	2.0
161 feet (70 psi)	Watts	100	197	332	494	682	826
	Kwh/mo.	72	142	239	355	491	594
	GPM	4	8	14	20	28	34
	Pipe diam. (in.)	1.5	1.5	2.0	2.0	2.0	2.0
184 feet (80 psi)	Watts	109	220	413	579	826	1015
	Kwh/mo.	79	158	297	417	594	730
	GPM	4	8	15	21	30	37
	Pipe diam. (in.)	1.5	1.5	2.0	2.0	2.0	2.0
207 feet (90 psi)	Watts	154	279	497	683	994	1239
	Kwh/mo.	111	201	357	491	715	892
	GPM	5	9	17	22	32	40
	Pipe diam. (in.)	1.5	1.5	2.0	2.0	2.5	2.5
230 feet (100 psi)	Watts	172	310	586	791	1169	1484
	Kwh/mo.	123	223	422	569	841	1168
	GPM	5	9	17	23	34	43
	Pipe diam. (in.)	1.5	2.0	2.0	2.5	2.5	2.5
288 feet (125 psi)	Watts	258	431	770	1029	1547	1981
	Kwh/mo.	185	310	554	740	1113	1426
	GPM	6	10	18	24	36	46
	Pipe diam. (in.)	1.5	2.0	2.0	2.5	2.5	2.5

Watts—constant generated wattage; kwh/mo.—kilowatt hours per month; GPM—gallons per minute water flow; PSI—pounds per square inch in working water pressure.

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The heart of hydro: turbines

Unless your interest in water power is purely romantic, forget dreams of a huge grist-mill-type wheel churning slowly at the side of your house. Such wheels, while fairly efficient when applied to turning millstones, do not adapt well to spinning generator rotors at high speeds.

Better suited, because of its low cost, low water-volume needs, and adaptability to generator speeds, is the impulse or Pelton wheel such as the one shown on this month's cover. About 1870, Allen Pelton observed that the flat paddle wheels or "hurdy-gurdies" used by gold miners were inefficient because the high-velocity water jet would split as it struck the flat paddle, leaving an area of dead water at the center that did no work. The double-cup design he developed is much more efficient. Since then, cup contours and lip clearances have been refined to prevent the retreating lips of one cup from impairing flow to the oncoming cup.

IPD sells a Pelton with a four-inch wheel. Small Hydroelectric Systems and Equipment offers plans and/or parts for Peltons with six-, nine-, and 18-inch wheels.

Another type of turbine suitable for small-scale power generation is the Banki/Michell or cross-flow turbine. In this turbine, water discharged from a rectangular nozzle strikes a multi-bladed runner or wheel. Unlike the Pelton, which is most efficient at high heads (50 feet or more), the Banki/Michell can be used in low-head installations. They have been designed to operate with as little as a three-foot head.

Ossberger Turbinenfabrik makes cross-flow turbines capable of producing 1.5 to 8 kw. Plans to build one with a 12-inch runner are available from Volunteers in Technical Assistance.

Another turbine that can be used successfully in on-site applications is the reaction-type, or Francis. In the Francis, water floods a housing around a series of guide vanes and flows inward through the vanes to drive a bladed runner. In a variation, called a Nagler or Kaplan, the runner resembles a boat propeller, which can have either fixed or variable pitch. Runner speeds on reaction turbines are adequate for direct or moderate step-up drive to spin a generator.

The Leffel Company, one of the oldest turbine builders still in business, offers the Francis turbine in models ranging from ½ to 10 kw. Called Hoppes units, Leffel designs the turbines for heads from eight to 25 feet. Bill Delp of IPD sells a fixed-pitch propeller version that he recommends for heads between five and 50 feet.

Impulse or reaction?

Pelton turbines can be run with as little as 1.5 cubic feet per minute (cfm) of water, but they operate most efficiently with at least a 50-foot head. Bill Kitching of Small Hydroelectric Systems and Equipment provides performance specs that show 0.04 hp at a flow of 1.56 cfm and 705 rpm for a six-inch-diameter Pelton turbine with a 20-foot head. Go to 50 feet, 2.45 cfm, and 1021 rpm, and you get 0.17 hp. Take the same runner with a 500-foot head, 7.86 cfm, and 3610 rpm, and you're producing 5.57 hp. Let's convert this to kilowatts (theoretically, 1.3415 hp = 1 kw, but allowing for losses, a more practical figure is 1.5 hp/kw; Bill Kitching uses 2 hp/kw): The six-inch Pelton will generate about 3.7 kw. To approximate the same power with Leffel's reaction turbine, you'd need a flow of about 250 cfm, compared to the 7.86 for the Pelton.

Continued

Peltons from kits: Bill Kitching shows 18″ and 9″ runners. You can buy castings bored or rough, buckets to mount on a plate yourself, or a complete turbine package. Notched lip of buckets improves efficiency. Output of 9″ runner is given in chart below.

Output of 9″ Pelton wheel

Calculations based on ⅝″ nozzle

RPM listed is optimum; wheel will produce about same power at 15 percent above or below optimum rpm. Kitching figures 2 hp gives 1 kw.

Head (ft.)	Water flow (cu. ft./sec.)	(gpm)	Rpm	Hp
50	0.12	54	664	0.55
75	0.15	68	813	1.0
100	0.17	77	939	1.6
125	0.19	86	1050	2.2
150	0.21	95	1150	2.9
200	0.24	108	1328	4.4
250	0.27	122	1485	6.2
300	0.3	135	1626	8.2
400	0.35	158	1757	12.6
500	0.39	176	2099	17.5

Outputs with various DC and AC alternators

Total head including head loss	Water flow per size nozzle (gpm)	(cu. ft./sec.)	Pipe lengths & sizes for same pressure loss	Alternator model (amps, watts, ratio, rpm)
12-VOLT ALTERNATORS				
35′ / 5′ loss / 40′ total	1⅛″ nozzle / 135	0.3	78′/3″ pipe or 330′/4″ pipe	'68 Chrysler 26 amps, 360 watts, 9:1, 3100 rpm
50′ / 5′ loss / 55′ total	1⅛″ nozzle / 180	0.4	200′/4″ pipe or 1200′/6″ pipe	'68 Chrysler 44 amps, 600 watts, 9:1, 3100 rpm
62′ / 7′ loss / 69′ total	1⅛″ nozzle / 198	0.44	225′/4″ pipe or 1700′/6″ pipe	Leece Neville 70 amps, 1050 watts, 4:1, 2000 rpm
150′ / 22′ loss / 172′ total	⅝″ nozzle / 76	0.17	390′/2.5″ pipe or 1000′/3″ pipe	Motorola 85 amps, 1200 watts, 4:1, 3100 rpm
24-VOLT ALTERNATOR				
70′ / 5′ loss / 75′ total	1⅛″ nozzle / 211	0.47	1000′/6″ pipe	Leece Neville 50 amps, 1400 watts, 4:1, 1800 rpm
120- AND 240-VOLT AC ALTERNATORS				
85′ / 13′ loss / 98′ total	1⅛″ nozzle / 233	0.52	300′/4″ pipe or 2300′/6″ pipe	Winpower 120 volts AC, 2000 watts, 4:1, 1800 rpm
130′ / 8′ loss / 138′ total	1⅛″ nozzle / 287	0.64	1000′/6″ pipe	Winpower 120/240 volts AC, 4000 watts, 3:1, 1800 rpm
200′ / 12′ loss / 212′ total	1⅛″ nozzle / 355	0.79	1000′/6″ pipe	Winpower 120/240 volts AC, 4000 watts, 2.5:1, 1800 rpm
375′ / 22′ loss / 397′ total	1⅛″ nozzle / 485	1.08	1000′/6″ pipe	Winpower 120/240 volts AC, 20,000 watts, 3:1, 1800 rpm
700′ / 79′ loss / 779′ total	1⅛″ nozzle / 664	1.48	2000′/6″ pipe	Maximum horsepower or 50,000 watts

Outputs you can expect at typical heads and water flows from DC and AC alternators are shown in the chart above. Estimated cost for home-built Pelton turbine to produce outputs shown for 12- and 24-volt DC alternators: $150 for bucket kit, shaft, and bearings, plus $40 for alternator. You add housing, pipe, fittings. AC system costs more.

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If you have a high water volume and a low head, your turbine choice would likely be a reaction-type, since it's driven by the water's mass rather than its velocity. Conversely, if you have a high head and low water volume, your choice would be a Pelton turbine since it uses the water's high velocity rather than its mass.

Francis Soltis of Alaska Wind and Water Power offers this rule of thumb: "Doubling the fall height with the same amount of water doubles power. Doubling the quantity of water with the same fall height doubles power. Doubling both the quantity of water and the fall height results in four times the power."

AC and/or DC?

Although a few turbines have been coupled to refrigeration compressors, and others drive pumps and machinery directly, the application with the most potential is electrical power. There are several possibilities:

- DC directly from alternator or DC generator.
- DC to batteries for DC tools and lights.
- DC to batteries to inverter to AC.
- DC to Gemini converter to AC.
- AC direct to load.

Straight DC, which may vary somewhat in voltage, is least costly. One of my neighbors has an ancient Leffel turbine driving an old welding generator feeding directly into his home heating system. A drawback with DC is that it requires heavy power lines and can't compete with AC for ease of distribution over great distances.

Storing energy in batteries, using a 12-, 24-, or 32-volt system, compensates for uneven water flow since energy is stored during low-usage periods. That isn't the only advantage batteries offer, however. Given unlimited finances and license to use all the water they want, most water-power developers would like to produce direct AC. The problem is that such an installation requires a big enough turbine and generator, plus enough water, to handle peak loads. This, of course, is the problem that plagues the utilities: Peak-load capacity, plus a little margin, costs far more than sizing a plant for mean load.

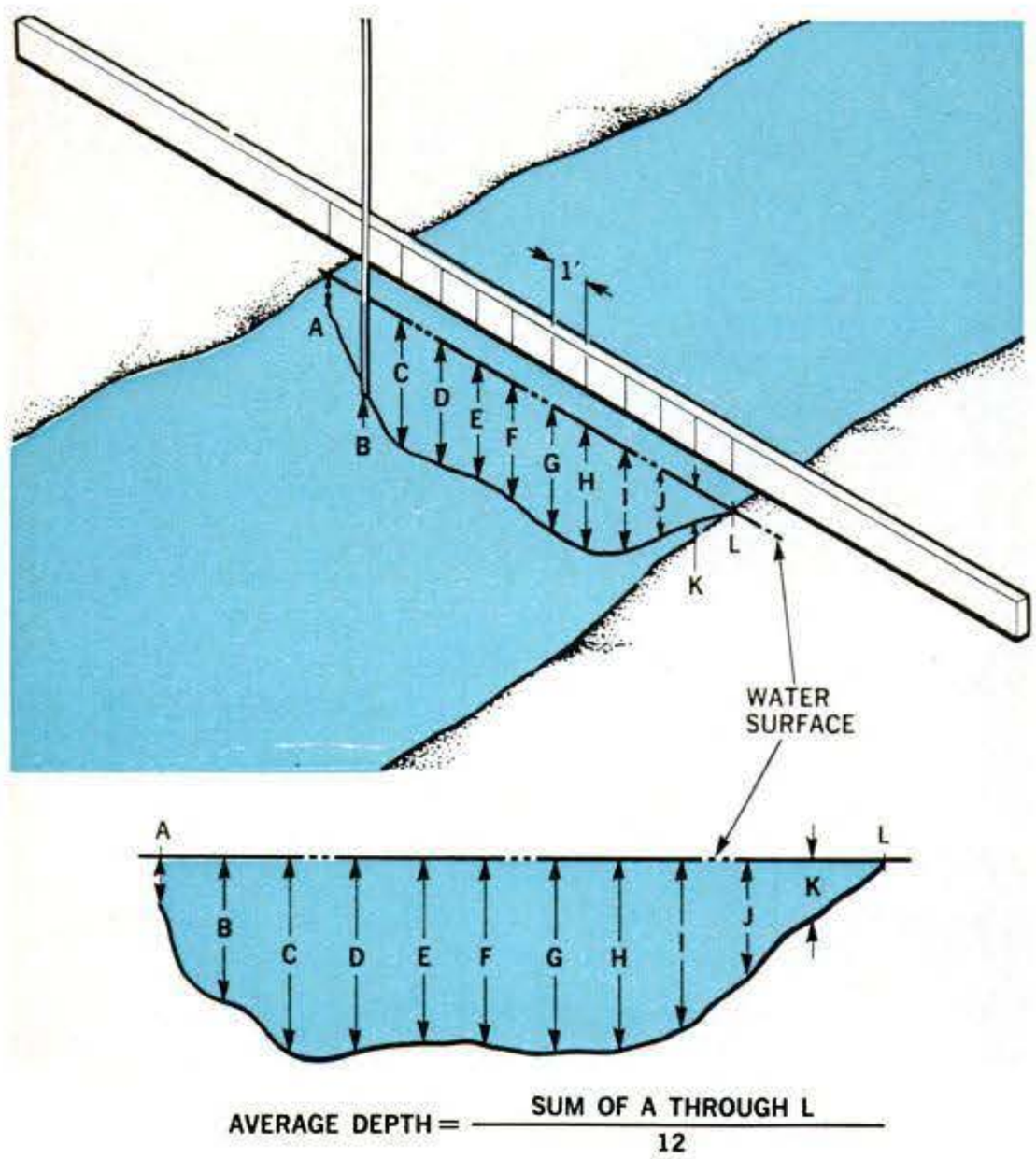
In a private plant it means water reserve behind a dam, headwater controls, and perhaps a turbine and generator twice as large as would be needed for mean load. In addition, a governor must be used to hold AC frequency. By using batteries as storage, you can size your plant for mean load and let the batteries handle the peaks. This can mean the difference between a two-inch-diameter inlet pipe taking a small, acceptable diversion from a stream; and a four- or six-inch pipe, a dam, and a waterflow that your neighbors and the authorities won't accept.

You can change DC battery power to AC with an inverter, but you'll lose some power in the process. Moreover, inverters are expensive, and some are limited in handling the surge demands of motor startup on many common appliances such as refrigerators.

If you already have a power line—and most people are hooked up to a utility—a Gemini converter might be useful. It lets you avoid batteries, enjoy standard 60-Hz power, and use whatever power your turbine will produce while still being able to draw power from the utility when water power is not enough. [For more information on how the Gemini power-conversion unit converts DC to AC and matches an on-site power source with a utility line, see "Wind Power Without Batteries," PS, Oct. '75.]

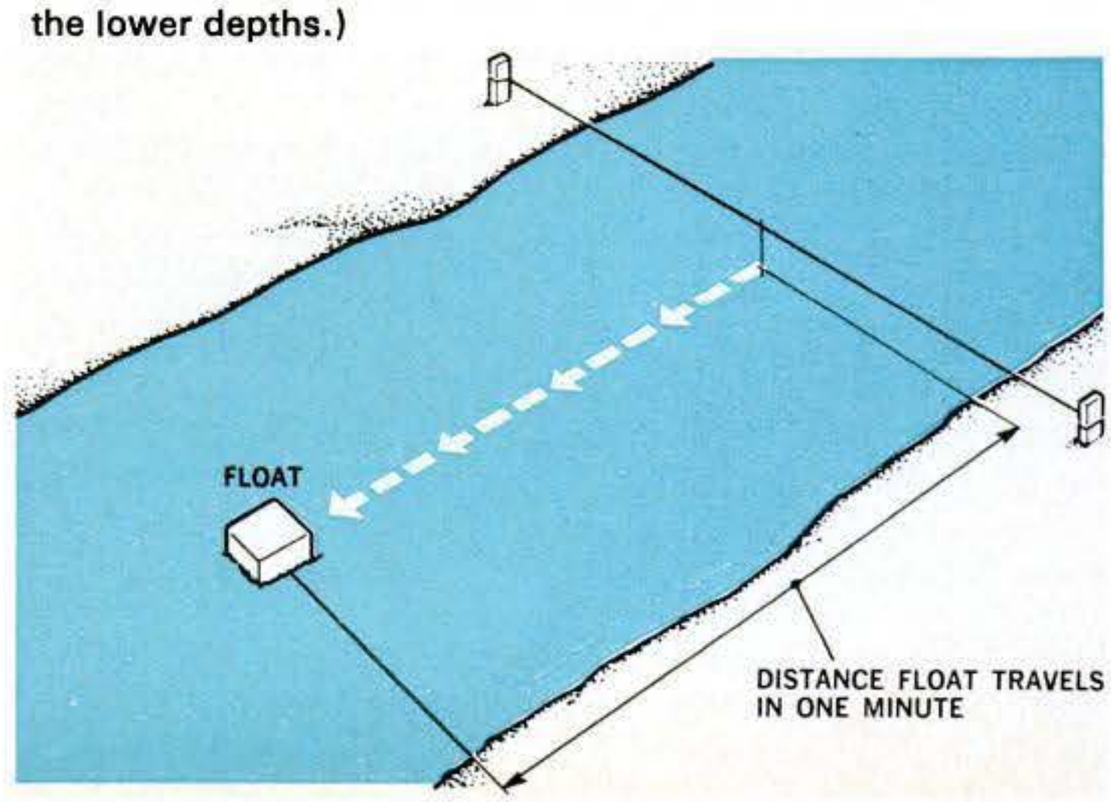
Generating AC direct to load, given the needed water, does eliminate batteries, inverters, and DC-transmission problems. AC does require constant frequency, however. For this you'll need a governor to control the speed of your turbine. A governor does three things: It measures the rotational speed of a prime mover; it corrects changes of speed, plus or minus, from a preset speed; and it supplies physical force to the throttling device to make corrections.

On a diesel engine, the governor moves a throttle to control speed. On a water turbine it must move a valve or diverter. The difficulty with governing a water turbine is that unlike the almost frictionless diesel throttle, the full force of the water jet is striking the



Measuring flow with a float

If stream is fairly consistent in width and depth, you can use this method. Mark board at one-ft. intervals and place across stream; measure water depth at each mark and record. Then draw cross section to determine square footage by either averaging measurements or by subdividing into rectangle and two triangles and figuring area. Use weighted float that can be clearly seen, and multiply feet traveled by float in one minute by square feet of cross section. Multiply this figure by 0.83 for water flow in cu. ft./min. (The 0.83, or 5/6, is difference in flow rate between the water at the stream's surface and the lower depths.)



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diverter, and it takes positive power to make the corrections. Recently, developers such as Dewey Smith, a venerable turbine builder in Washington state, have been using rebuilt Woodward UG-8 diesel governors. This is an extremely precise hydraulic governor that costs about $500. A hydraulic pump built into the unit supplies the muscle to move the diverter.

In my opinion the UG-8 is too costly and sophisticated for this job; I'd use a heavy-duty mechanical governor from a large gasoline engine, preferably one that's been scrapped. For a fraction of the cost, you'd get about three- to five-percent regulation of speed, which is adequate.

Driving the load

Unless you're going back to twisted flat belts and millstones, you'll want to couple the generator to the turbine with a drive that provides the right rotor speed whether you're generating DC or AC. Bill Delp's IPD unitized rigs, which put out DC to charge batteries, need no step-up drive: A flat plate supports the turbine, and the alternator is keyed into the runner from the opposite side of the plate for a direct shaft-to-shaft drive.

If you're building a system, the turbine speed and the required speed of the generator will determine the drive ratio. You can use V-belts, flat belts, or an old automobile differential to produce the necessary output speed. Differentials are popular since they can be obtained as scrap, offer a range of ratios that are about right, and can easily take the full power of most turbines. The drive shaft also lets you mount the generator away from the turbine.

Is water power cost-competitive?

- If you're thinking of producing as much power for your home as you could get from a utility line, the chances of recovering your costs are slight.
- If you're planning a water-power installation in a remote area where your only other choice is a diesel- or gasoline-driven generator, your long-term savings may be huge.

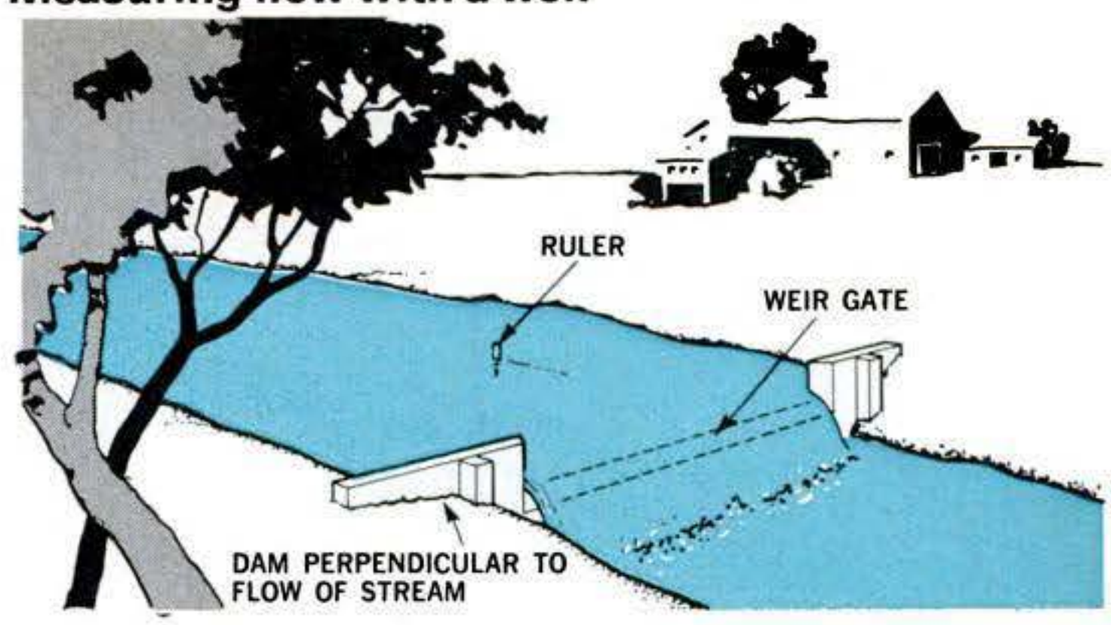
The first statement reflects the size of dam, generator, and turbine needed to provide peak capability, any time, any season, to back up a 20-kw direct-AC home need. The second reflects the savings on fuel and maintenance for a small-scale hydroelectric installation. (Such a plant may cost about the same as a modest diesel plant—probably from $5000 to $10,000.) Typically, the installations I visited had been operating continuously for 15 or 20 years at a yearly cost of about $5 for lubricants and repairs.

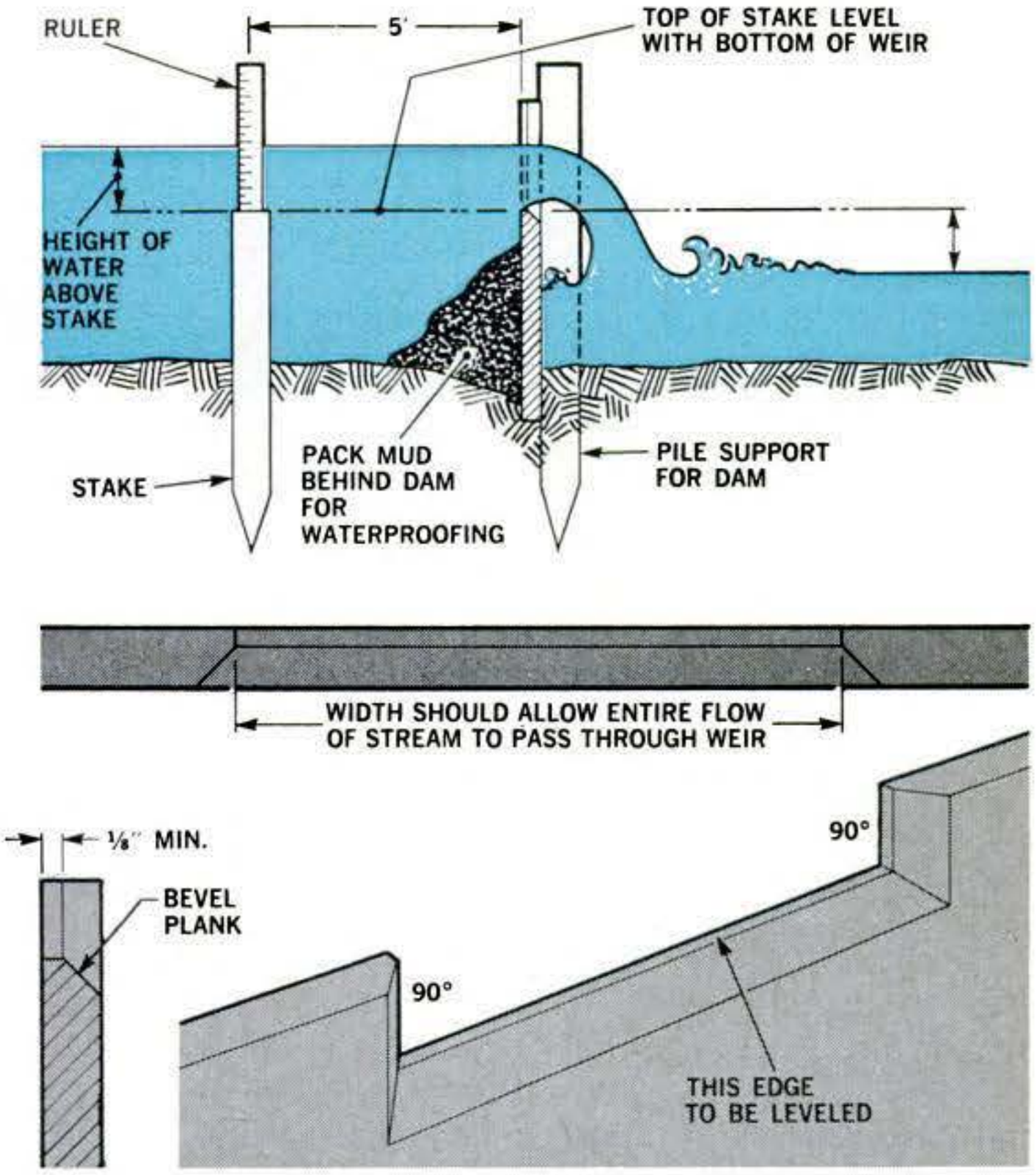
Bill Delp says that anyone who can handle a pipe wrench and screwdriver can install one of his IPD unitized turbine/alternator packages. IPD's Pelton turbine system costs $985; a propeller turbine version is $1495. IPD's systems seldom require a dam; the intake is merely a screened pipe in a stream or spring. Four or six deep-discharge batteries provide storage. These cost from $90 to $125 each; Delp claims they'll last 15 years or more. If you want AC, you'll have to add an inverter. These start at $700 for a one-kilowatt unit and go up to $7700 for a 12-kilowatt rig. A six-kilowatt inverter costs $2500. Delp says he can offer a complete system, including pipes and valves, for 75 cents to $1.10 per peak watt for a high-head outfit; $1.05 to $1.45 for low head. His packages are available in three-kw increments up to 18 kilowatts.

Many water-power experimenters have a genius for picking up used DC and AC generators, often at junk

Continued

Measuring flow with a weir





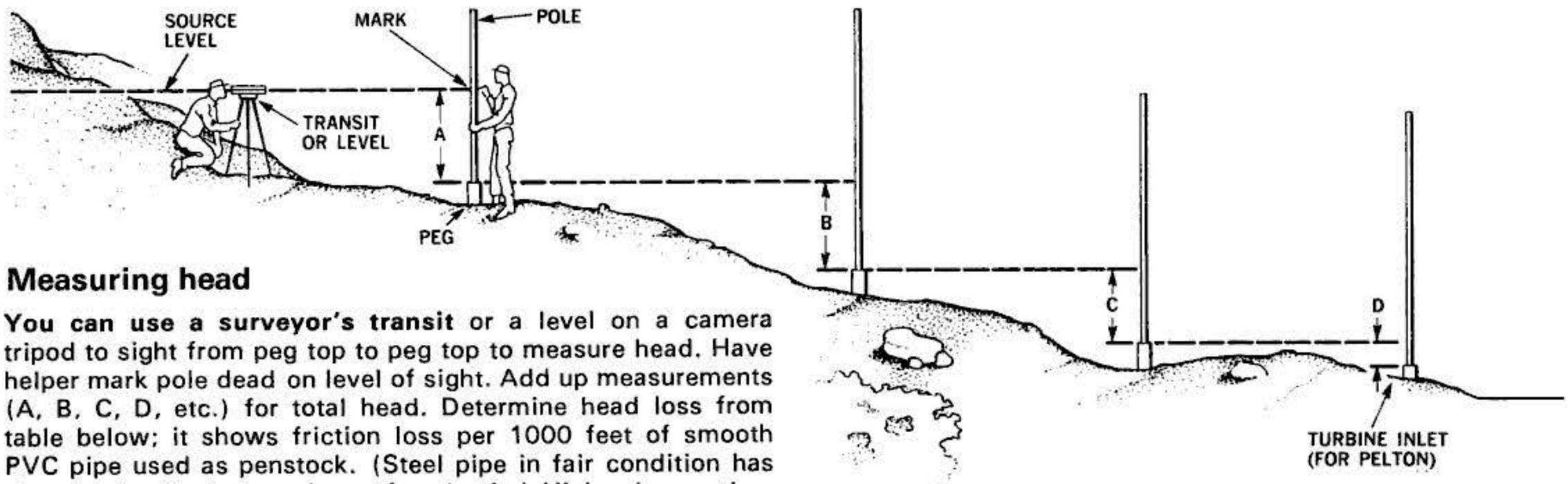
Construct weir gate and determine height of water above stake as shown above. Figure flow from chart below.

Weir measurement table

Table shows water flow (in cu. ft./min.) that will flow over a weir one inch wide and from ⅛ to 20⅞ inches deep.

inches		⅛	¼	⅜	½	⅝	¾	⅞
0	0.00	0.01	0.05	0.09	0.14	0.19	0.26	0.32
1	0.40	0.47	0.55	0.64	0.73	0.82	0.92	1.02
2	1.13	1.23	1.35	1.46	1.58	1.70	1.82	1.95
3	2.07	2.21	2.34	2.48	2.61	2.76	2.90	3.05
4	3.20	3.35	3.50	3.66	3.81	3.97	4.14	4.30
5	4.47	4.64	4.81	4.98	5.15	5.33	5.51	5.69
6	5.87	6.06	6.25	6.44	6.62	6.82	7.01	7.21
7	7.40	7.60	7.80	8.01	8.21	8.42	8.63	8.83
8	9.05	9.26	9.47	9.69	9.91	10.13	10.35	10.57
9	10.80	11.02	11.25	11.48	11.71	11.94	12.17	12.41
10	12.64	12.88	13.12	13.36	13.60	13.85	14.09	14.34
11	14.59	14.84	15.09	15.34	15.59	15.85	16.11	16.36
12	16.62	16.88	17.15	17.41	17.67	17.94	18.21	18.47
13	18.74	19.01	19.29	19.56	19.84	20.11	20.39	20.67
14	20.95	21.23	21.51	21.80	22.08	22.37	22.65	22.94
15	23.23	23.52	23.82	24.11	24.40	24.70	25.00	25.30
16	25.60	25.90	26.20	26.50	26.80	27.11	27.42	27.72
17	28.03	28.34	28.65	28.97	29.28	29.59	29.91	30.22
18	30.54	30.86	31.18	31.50	31.82	32.15	32.47	32.80
19	33.12	33.45	33.78	34.11	34.44	34.77	35.10	35.44
20	35.77	36.11	36.45	36.78	37.12	37.46	37.80	38.15

Example of how to use weir table: Suppose depth of water above stake is 9⅜ inches. Find 9 in the left-hand column and ⅜ in the top column. The value where they intersect is 11.48 cu. ft./min. That's only for a 1"-wide weir, however. You multiply this value by the width of your weir in inches to obtain water flow.



Measuring head

You can use a surveyor's transit or a level on a camera tripod to sight from peg top to peg top to measure head. Have helper mark pole dead on level of sight. Add up measurements (A, B, C, D, etc.) for total head. Determine head loss from table below; it shows friction loss per 1000 feet of smooth PVC pipe used as penstock. (Steel pipe in fair condition has about twice the losses shown for plastic.) Higher losses than 333 feet per thousand result in decreasing power gain with increasing flow.

Head loss for 2" to 6" plastic pipe

GPM	23	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675
Cu. ft./sec.	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
Pipe size	Head loss per 1000 feet of pipe															
2"	18'	63'	230'	*												
2½"	6'	21'	75'	161'	274'	**										
3"	2'	9'	30'	64'	110'	166'	234'	312'	***							
4"	½'	2'	7'	15'	26'	40'	56'	74'	95'	118'	144'	172'	201'	230'	268'	305'
6"	0	¼'	1'	2'	4'	5'	7'	10'	13'	16'	19'	23'	27'	30'	36'	40'

*Maximum head loss for 2" pipe (333' per 1000') is reached at 110 gpm or 0.24 cu. ft./sec.
**Maximum head loss for 2½" pipe: 200 gpm. ***Maximum head loss for 3" pipe: 326 gpm.

prices. But a new generator from a company such as Lima Electric is so much preferable to the oldies in terms of regulation and insulation that you'll probably gain more than the additional cost in time otherwise spent in making ill-suited equipment perform properly.

Francis Soltis quotes a 2.5-kw, 115-v, 60-Hz, 1800-rpm alternator at $950. A 5-kw, 115/230-v, 60-Hz, 1800-rpm rig runs $1300.

You can build your own turbine. Kitching and Soltis work together on this. Plans for an 18-inch Pelton runner are $16; a housing plan for the runner costs $10. A set of 15 cast-aluminum buckets for you to slot and drill run $100. An 18-inch runner with buckets (not including shaft) costs $275. The same wheel mounted on a shaft is $450. The complete basic turbine: $1190. Kitching and Soltis also offer six- and nine-inch Peltons.

Obviously, you can save quite a bit if you can do a little machining, can cut and weld ¼" plate for a housing, know how to align bearings, and can build and wire an electrical panel.

Back to the source

Before you invest in any water-power hardware, you'll have to measure your power source. Flow volume in cubic feet per minute, and head or "fall," to quote both Bill Kitching and the Leffel Company, are the absolutes of water power. You *must* know how much water you can deliver to the turbine and how high the water source is above the turbine. You must also know how long the penstock or feed-in pipe will be so you can calculate friction losses.

It's normal for water sources to vary from season to season—a roaring spring freshet may dwindle to a sluggish trickle in August—so you should measure the flow over a year or more. There are three methods: temporary dam, stopwatch, and bucket; float and stopwatch; and temporary dam and weir gate.

The dam-and-bucket system is suited to a small flow such as a spring or brook. You build a box-like containment to catch all the water, and provide an outlet pipe to spill the entire flow into a container such as a five-gallon bucket. Time the period needed to fill the bucket, and you can easily figure the flow in cubic feet per minute. (One gallon is 0.1337 cu. ft.)

The float method is useful when you can lay off 150 feet or more of a stream where the width and depth are fairly constant. The drawings show you how to determine flow with this system.

The temporary dam and weir gate is, perhaps, most accurate. A board with bevel-notched opening or a weir dams off the stream so all the water flows through the weir (see drawing). Flow is determined from the table included with the drawings.

Measuring head and head loss

You can use a surveyor's transit or a pole and level to find the height of the water source above the turbine (see drawing). There's a slight difference between impulse and reaction turbines: Kitching measures to the point of entrance (or nozzle) of the Pelton turbine. Leffel measures to the surface of the water below the discharge of the Francis turbine.

The third vital factor in estimating power is the friction or head loss in getting water from source to turbine. If your source is far up a hill or mountain, you'll probably build the inlet pipe or penstock of plastic or aluminum pipe—light and easily assembled. If you have a low-head installation at the foot of a dam, you'll still need some pipe, since it's common practice to locate the turbine as far down slope as possible to gain head. In either case, determine head loss from the table included with this article and trim your potential power source accordingly.

Handy tables you can use to calculate water power

POWER:
1 kw = 1.3415 hp = 0.948 Btu/sec. = 3413 Btuh
1 hp = 0.7455 kw = 0.707 Btu/sec. = 2547 Btuh
1 kwh = 3413 Btu = 1.3415 hp/hr.

BASIC WATER POWER AVAILABLE:
(Does not consider wheel and generator losses or pipe friction)

$$Hp = \frac{62.4 \text{ X cu. ft./min. X head in ft.}}{33{,}000}$$

VOLUME:
1 gal. = 0.1337 cu. ft.
1 cu. ft. = 7.48 gal.
1 acre ft. = 325,800 gal.

PRESSURE (FOR COLUMNAR HEIGHTS)
1 inch of water = 0.0361 lb./sq. in. = 5.2 lb./sq. ft.
1 foot of water = 0.433 lb./sq. in. = 62.4 lb./sq. ft.

FLOW QUANTITIES:
1 cu. ft./sec. = 60 cu. ft./min. = 7.48 gal./sec. = 448.8 gal./min.
1 cu. ft./min. = 0.01667 cu. ft./sec. = 60 cu. ft./hr. = 0.1247 gal./sec.
= 7.48 gal./min. = 448.8 gal./hr.
1 gal./sec. = 0.1337 cu. ft./sec. = 8.02 cu. ft./min. = 481 cu. ft./hr.
= 3,600 gal./hr.
1 gal./min. = 0.002228 cu. ft./sec. = 0.1337 cu. ft./min.
= 8.02 cu. ft./hr. = 0.01667 gal./sec.
1 gal./hr. = 0.0000371 cu. ft./sec. = 0.002228 cu. ft./min.
= 0.1337 cu. ft./hr. = 0.0002778 gal./sec. = 0.01667 gal./min.

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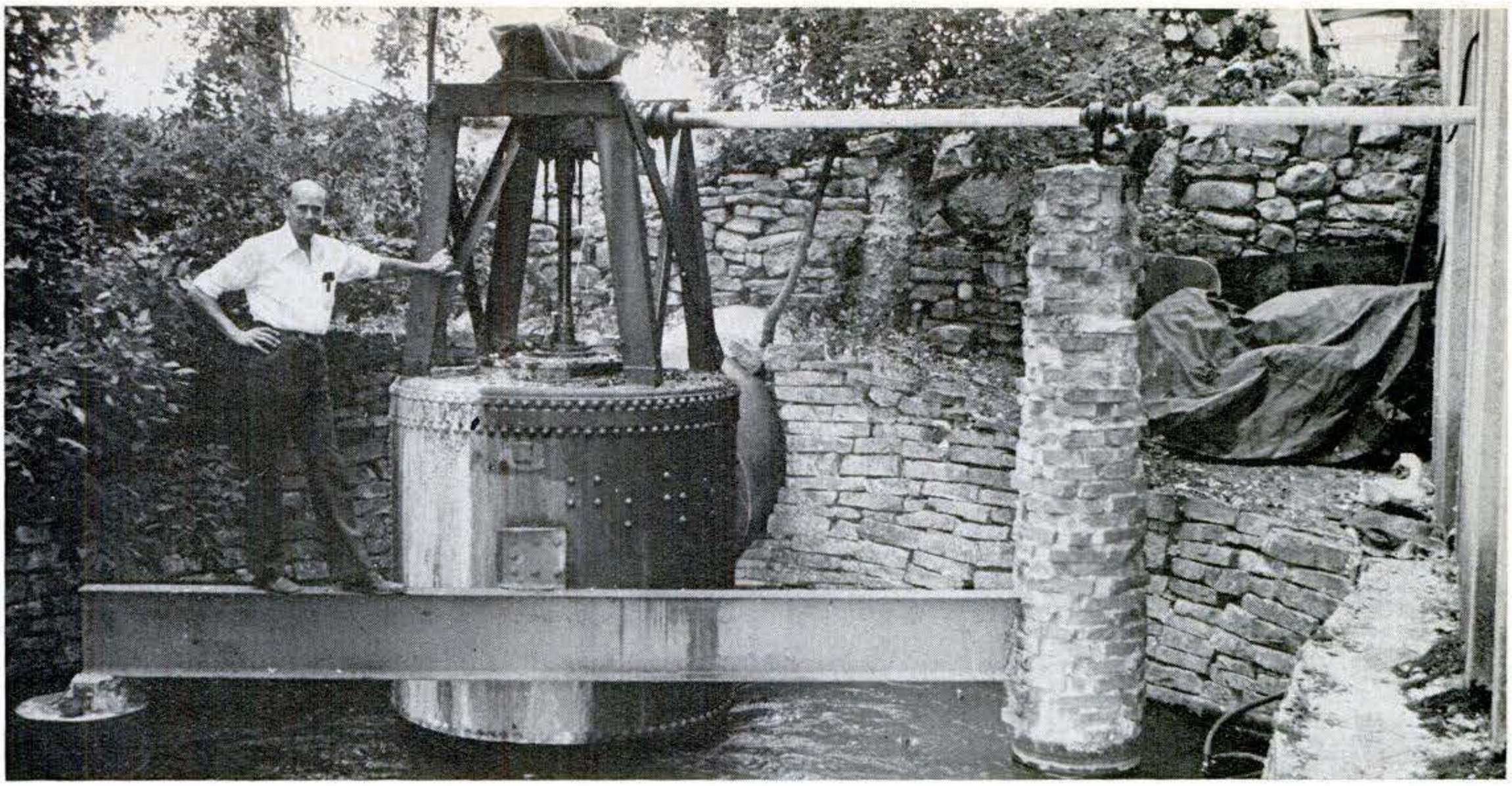

Francis turbine, made by the Leffel Co., drives a rebuilt welding generator for DC household heat. Ken Zerwekh of Delafield, Wis., started with old mill, penstock, dam, and pond. Today, cost would be enormous.

Although average water flow may not be suitable for full output 24 hours a day, it's not likely you'll need continuous full output. Thus, as with the old mill, where the "sound of the grinders was not heard after sunset," you can stop or reduce flow overnight and allow water to accumulate behind a dam.

Obviously, the size of the pond will depend upon land available for flooding, the soil's suitability for water retention, and other ecological considerations. It's also possible that you'll need a permit. How large a dam you build and what materials you use will depend upon your location, but even if you can get permission to build a dam, the costs today would be difficult to recover.

On the other hand, confining the flow of a small spring to provide a reservoir and suitable outlet pipe may be as simple as building a small, tub-like concrete structure and letting the overflow spill back into the spring. Diverting part of the flow of a small rivulet may be no more difficult, but since springs tend to flow at a fairly constant rate and rivulets have a way of becoming torrents, the need for a managed overflow path becomes important. And, although a spring may not be subject to floating trash, a stream in flood may slam anything from a fallen tree to your neighbor's outhouse into your diversion structure. Thus you'll need a trash rack, a grid-like protective barricade. If you choose the diversion route over a full-fledged dam, you'll need batteries if you want to store your water power.

Whether you tap a high mountain spring or stream or have a low-head dam, you'll need a means of stopping and controlling water flow for maintenance and power management. Most Pelton-turbine inputs have a gate valve just ahead of the discharge nozzle. With such a valve you can regulate the power to an approximate value and let the governor, if you use one, handle the fine tuning. Ideally, you'll also have a valve at the head of the penstock, since shutting off a high head of rushing water at the turbine must be done slowly to prevent a great impact on the penstock.

Most suppliers of small-scale hydroelectric equipment are eager to help you with the information and guidance you'll need to develop your own power source. Much information exists on on-site applications of water power (see For Further Reading); much of it has been well known since the late nineteenth century.

Be warned, however, that present-day water-rights laws and environmental concerns make many old-time methods unacceptable today. All of the water-power developers I talked with emphasized this. But Bill Delp points out something worth pondering: While legal and environmental factors often make the full use of available water impossible, you can make up for these constraints with modern technology. PS

FOR FURTHER READING

Energy Primer (Portola Institute, 1974): See chapter on water. This large-format paperback is available from Portola (558 Santa Cruz Ave., Menlo Park, Calif. 94025) for $4.50.

"Farm Water Power" by George Warren (Feb. 1931) and "Power for the Farm from Small Streams" by A. M. Daniels (Jan. 1925): U.S. Dept. of Agriculture pamphlets available from local extension agents.

Handbook of Homemade Power by the staff of *Mother Earth News* (Bantam, 1974): includes reprint of classic five-part series, "How to Build Your Own Water Power Plant," by C. D. Bassett, which originally appeared in *Popular Science* in 1947.

"How to build a Farm Pond" (Leaflet 259, 5¢) and "Ponds for Water Supply and Recreation" (Agriculture Handbook 387, 70¢): available from Government Printing Office, Washington, D. C. 20402.

"Low-Cost Development of Small Water Power Sites" by Hans W. Hamm: includes plans for a 12″ Banki/Michell turbine. Available from Volunteers in Technical Assistance (3706 Rhode Island Ave., Mt. Rainier, Md. 20802) for $2.25. VITA also offers plans for a one-kw river generator for $1.

Marks' Standard Handbook for Mechanical Engineers, Theodore Baumeister, ed. (McGraw-Hill, 1967 and earlier editions): see section on hydraulic turbines.

MAKERS OF WATER-POWER EQUIPMENT

Alaska Wind and Water Power, Box G, Chugiak, Alaska 99566: plans, components, complete systems; information package: $3. **Canyon Industries,** P.O. Box 2543, Billingham, Wash. 98225: information package: $1; presently developing complete system including Hydromite. **Independent Power Developers, Inc.,** Box 1467, Noxon, Mont. 59853: complete systems; a catalog is available for $2. **James Leffel & Co.,** Springfield, Ohio 45501: complete systems; ask for pamphlet A and bulletin H-49. **Lima Electric Co.,** 200 E. Chapman Rd., Lima, Ohio 45802: generators; **Ossberger Turbinenfabrik,** Weissenburg, West Germany: Banki/Michell turbines. **Pumps, Pipe & Power,** Kingston Village, Austin, Nev. 89310: complete systems. **Small Hydroelectric Systems & Equipment,** Box 124, Custer, Wash. 98240: plans, components, complete systems; information package: $3. **VITA:** plans for 12″ Banki/Michell turbine (see address above). **Windworks,** Box 329, Mukwonago, Wis. 53149: Gemini converter.

New Low-Cost Sources of Energy for Your Home by Peter Clegg ($5.95 from Garden Way Publishing, Charlotte, Vt. 05445): see chapter on water power.

Other Homes and Garbage by Jim Leckie **et al.** (Sierra Club, 1975): see "Electricity from a Stream."

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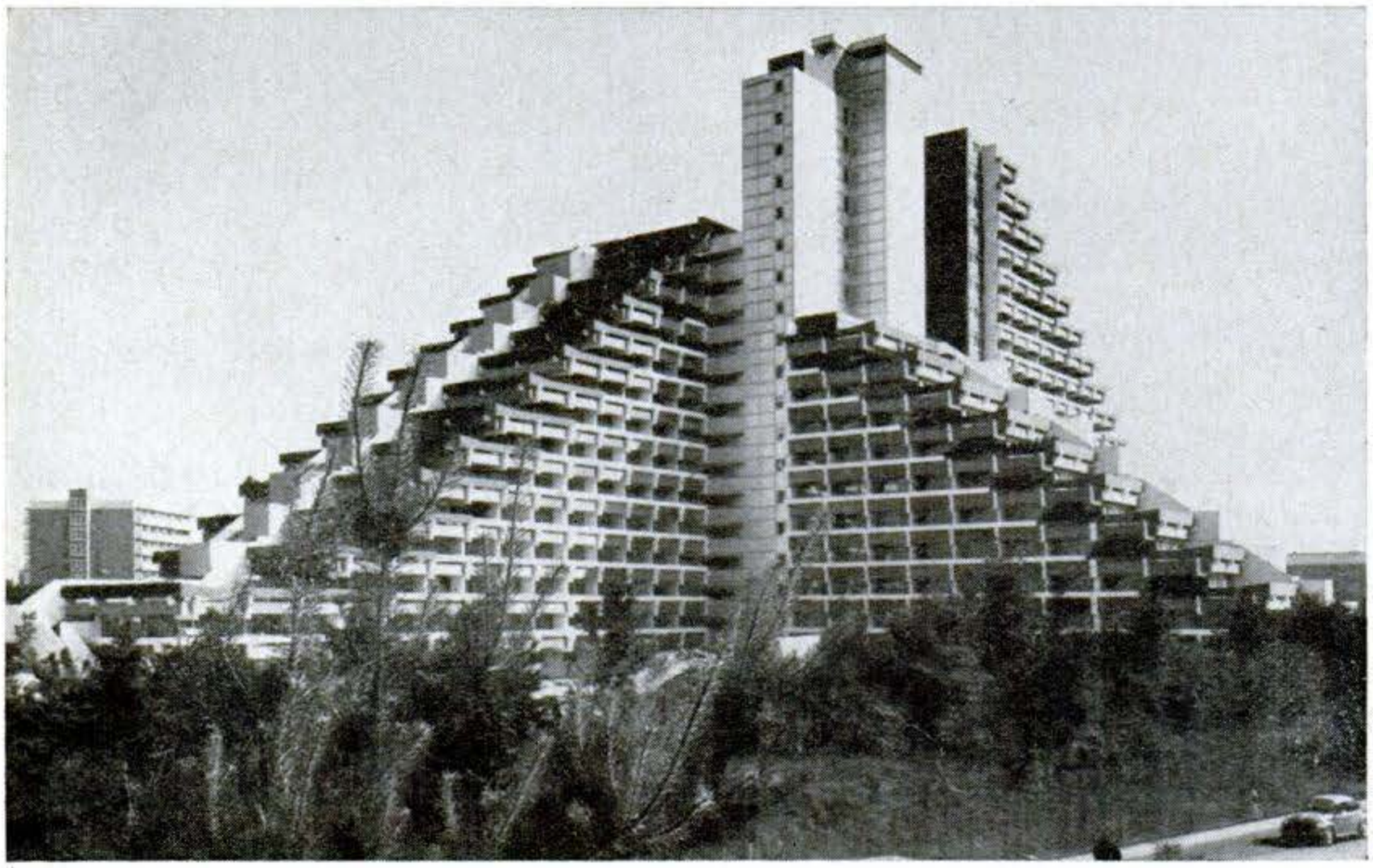
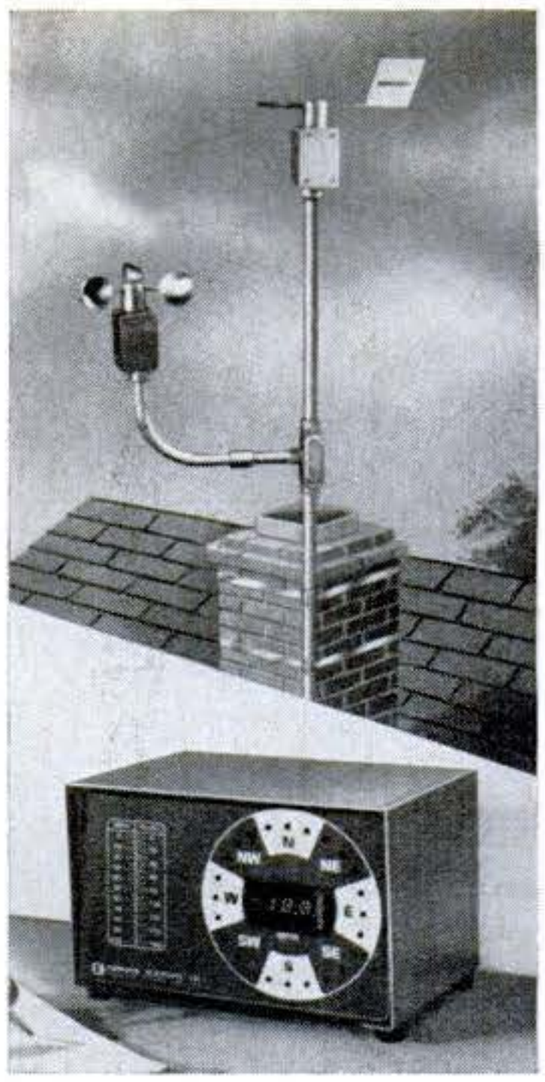
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Pyramid-shaped apartment house

This recently opened apartment building in Munich, West Germany, is called the Pharaoh because of its pyramid design. The 400-apartment structure has an aluminum skin made of 850 panels. Each panel is 3.6 meters wide and 2.5 meters high. The terraced structure was erected by the Aluminum Center of Düsseldorf, West Germany.

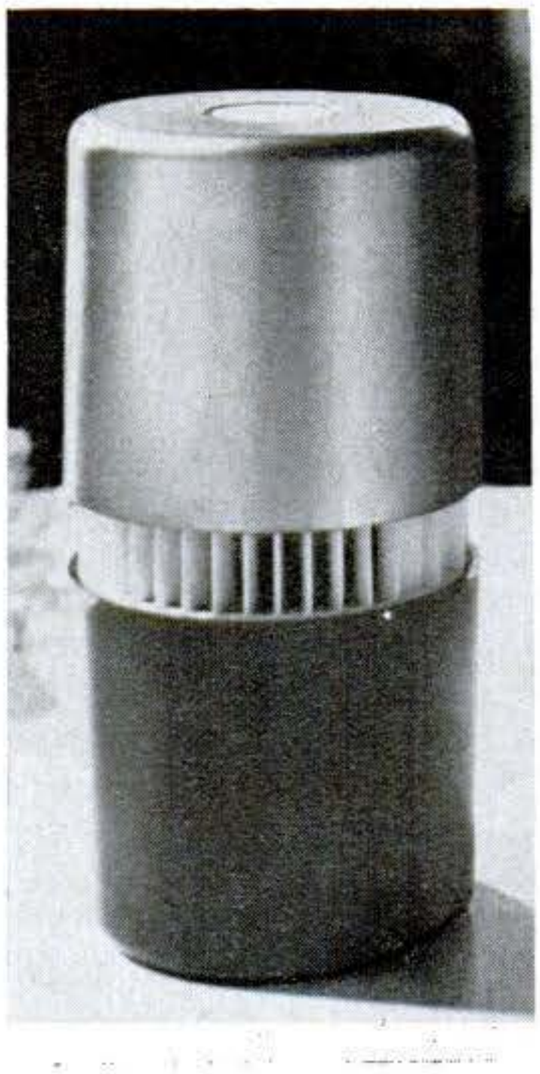


Digital anemometer

Don't like dial anemometers? This instrument gives you wind speed and direction digitally on an LED display that registers velocities of 0.5 to 120 mph. It runs on house current. $359.95 from Edmund Scientific, 555 Edscorp Bldg., Barrington, N.J. 08007.

Little Lincoln

Watch out, Seville! Here comes the Lincoln Versailles, a scaled-down luxury model, designed to be Ford's best-built car ever. Vehicle Electric Test System (left) is one of the new reliability checks to ensure top quality. It checks 90 percent of car's electrics in five minutes.



Room freshener

A solid-state timer turns this electronic air deodorizer on and off periodically to circulate an aromatic gel that neutralizes bad odors. The Ventaire is powered by four 1.5-volt batteries. It's made by Rizla Ltd., Severn Rd., Treforest Ind. Estate, Pontypridd, Mid. Glam, Wales.

Force gauge

Need to measure push and pull forces with high accuracy? The Accuforce digital force gauge lets you do it in hand-held mode or on a test stand. Readings are in kilograms or pounds, and it has a "hold-at-max" mode. Maker: Ametek, One Spring Ave., Hatfield, Pa. 19440. It's $595.

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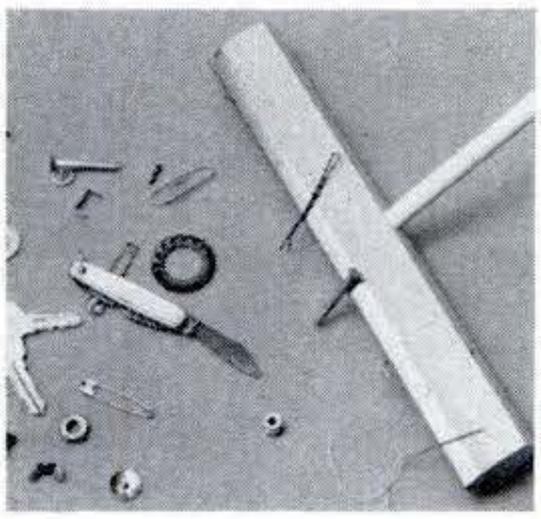
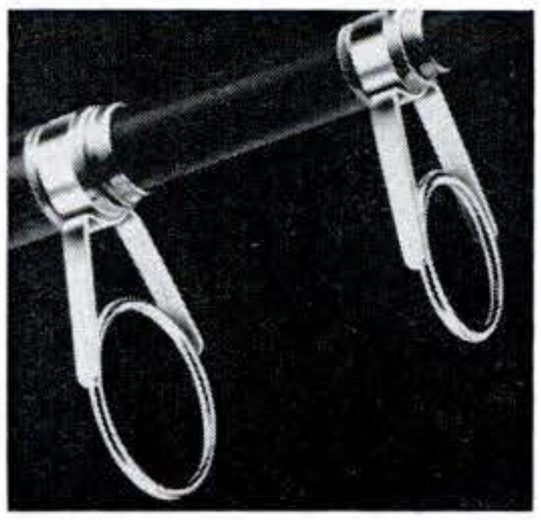
Midsize luxury

Chrysler's quiet-riding new LeBaron is a roomy luxury car with lots of interior space. It weighs only 3800 pounds, has a 112.7-in. wheelbase, and is 206.1 in. long. It's powered by a 318-cu.-in. V8 with an electronic Lean Burn system that controls spark firing with a minicomputer.



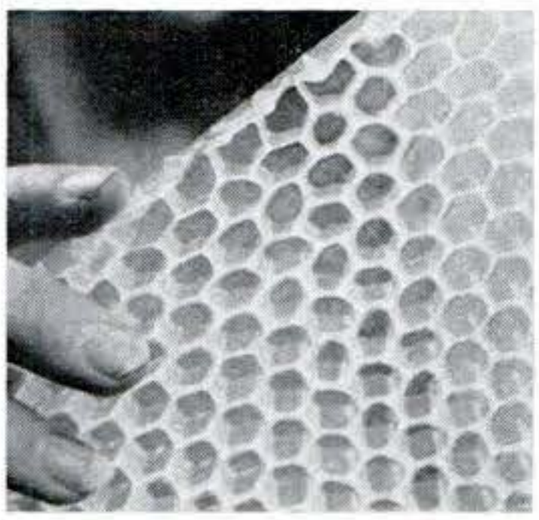
Magnetic broom

Drop nails or screws on the floor? This magnetic sweeper locates and gathers them up with a powerful ferrite bar magnet. The magnet is also handy for finding objects on carpets. It's made by Bisbell Magnetic Products, 9 Park Rd., Alrewas, Burton-on-Trent, Staffs, England.



Adjustable rod

A new ferrule system that locks the shaft at any point between 4½ and seven feet gives you a whole gamut of fishing rods in one. Klippsa's Multi-spinn can accommodate lures from 1/16 to ⅝ ounce. It's made by Trimarc, 4515 West Harrison St., Hillside, Ill. 60162.

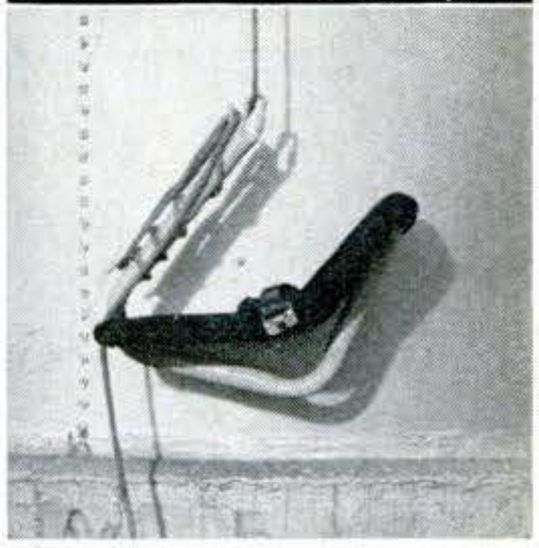


Collector cover

Is this the material that can make solar collectors cheaper? Battelle's Pacific Northwest Labs (Richland, Wash.) are testing this clear plastic sheet with honeycomb core to determine if it's more economical than other materials, including the standard double-glass type.

Sky seat

One rope and one moving part—a nut on the D ring—are all this bos'n chair requires for climbing storage silos or other high places. No other power is needed. Capacity: 1500 pounds. Maker: Cooper Tool Co., Inc., Box 52, Lisco, Neb. 69148. Price is about $285.

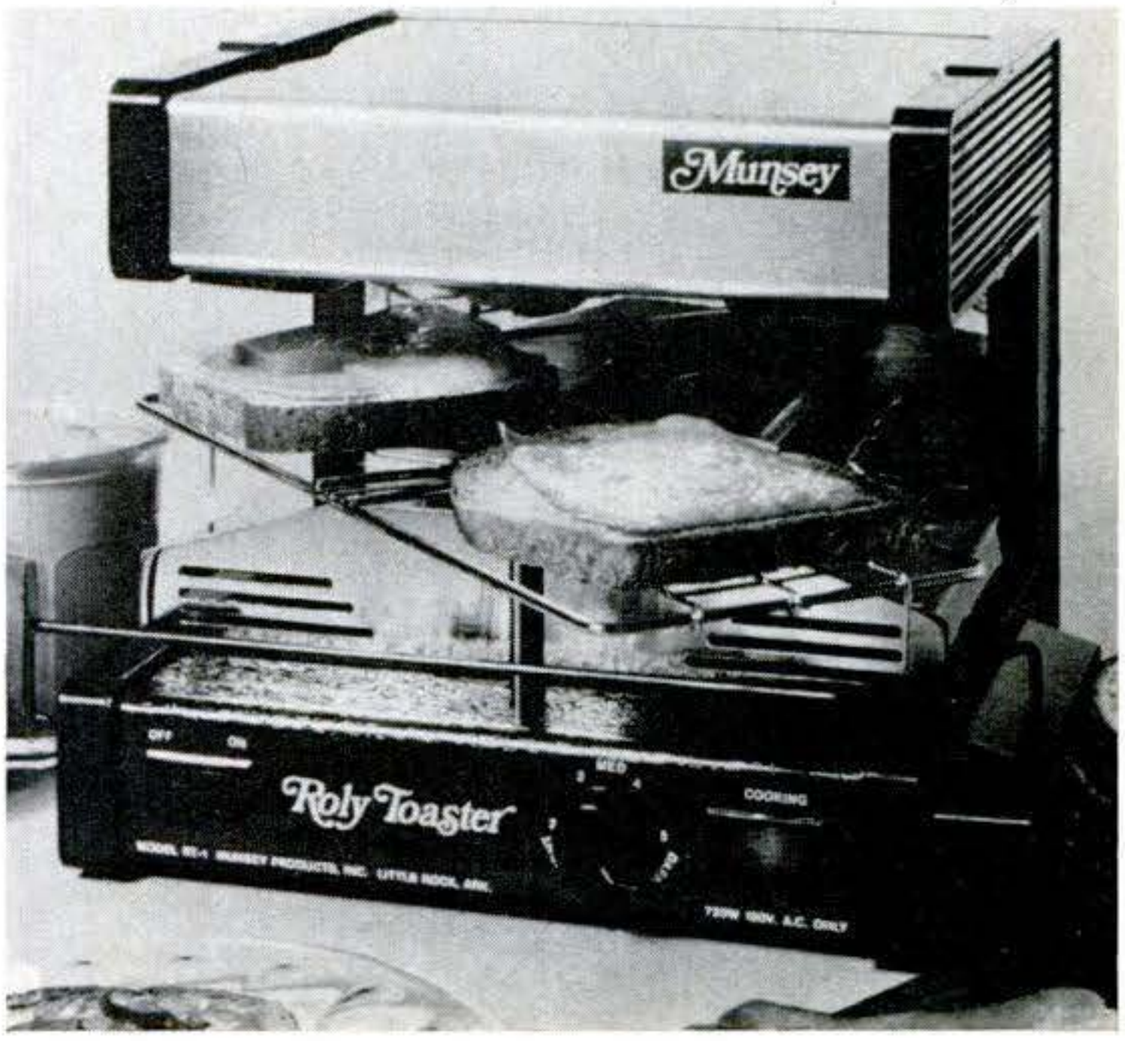


Traffic cop

The Plasticone doubles as a traffic barrier and direction giver. The cones can be quickly set up around accidents or excavations. Signs or lights mount on top to direct motorists. It's made by Swintex Ltd., Derby Works, Manchester Rd., Bury, Lancashire BL9 9NX, England.

Toaster

When the toast's done, this new toaster slides it onto a plate. A solid-state timer controls it. The Roly Toaster holds bread, muffins, and other items on a rack so you can pre-butter them. Munsey Products, Inc., 8507 New Benton Hwy., Little Rock, Ark. 72204. Price: $35-45.



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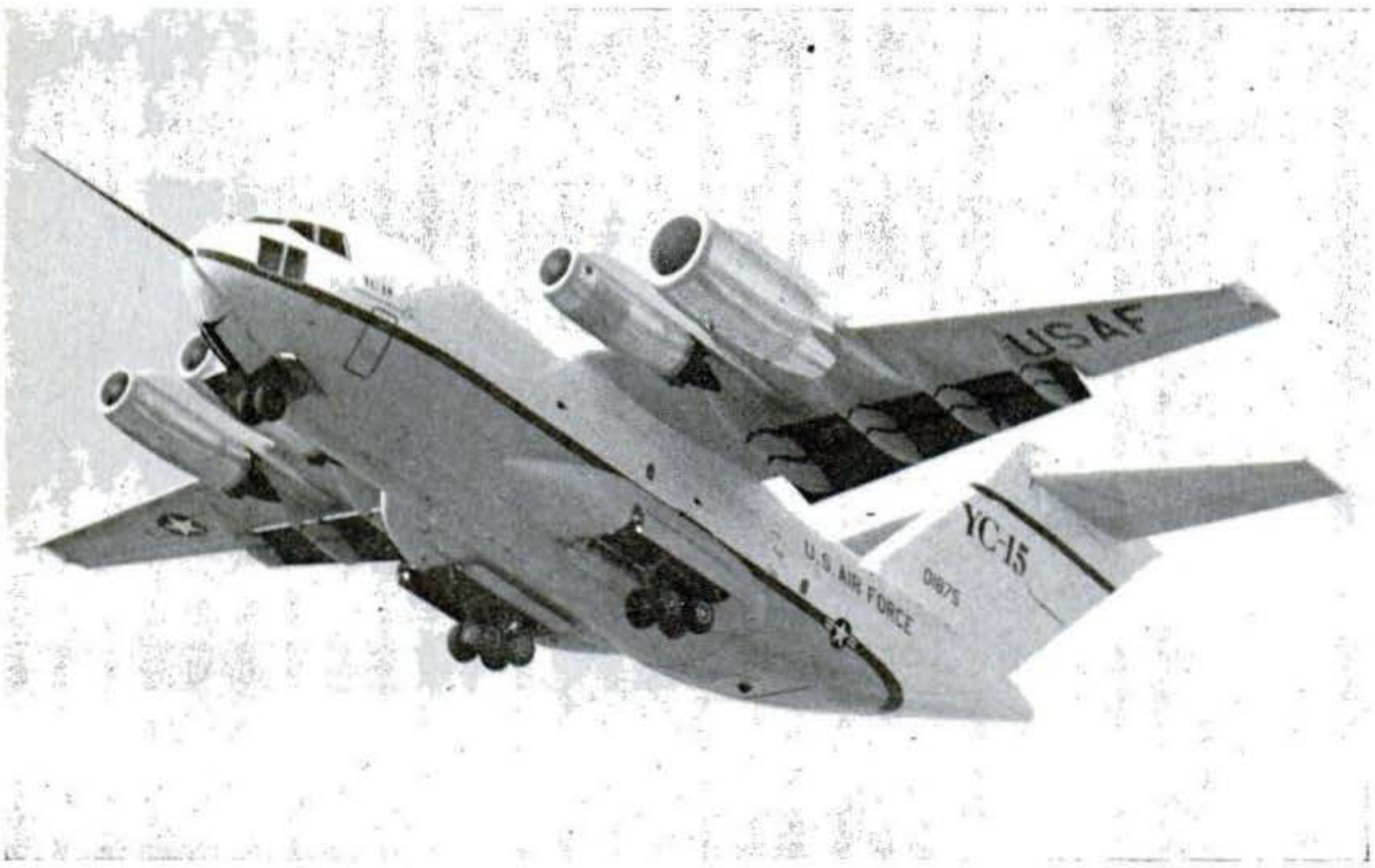
What's New

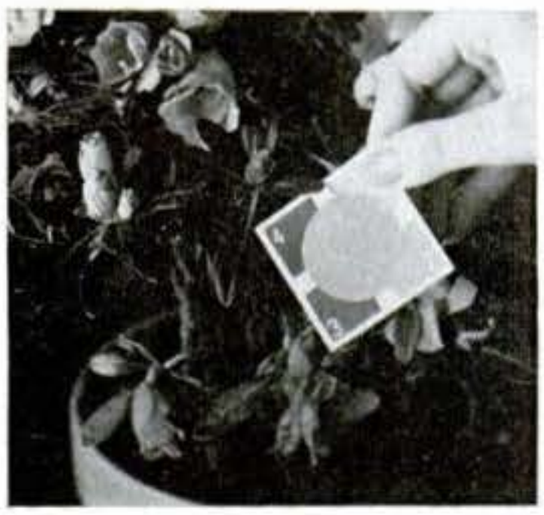
Top performer

After a two-year absence, the hot Camaro Z-28 returns. The new version features a suspension system designed to handle well at all speeds. A 350-cu.-in. V8 with four-barrel carb is standard, as are GR70x15 steel-belted radials. Price: $5170.



More powerful STOL

A new high-bypass engine has boosted the takeoff thrust of the YC-15 by 6000 pounds. The short takeoff-and-landing craft (STOL) has the new CFM-56 engine installed in the left outboard position. It generates 22,000 pounds of thrust. Each of the plane's other turbofans is in the 16,000-pound-thrust class. Jointly developed by General Electric and France's SNECMA, the new engine was recently flight-tested. The STOL prototype, being developed by McDonnell Douglas for the U.S. Air Force [PS, Feb '76], also has new, larger wings to increase flight range.

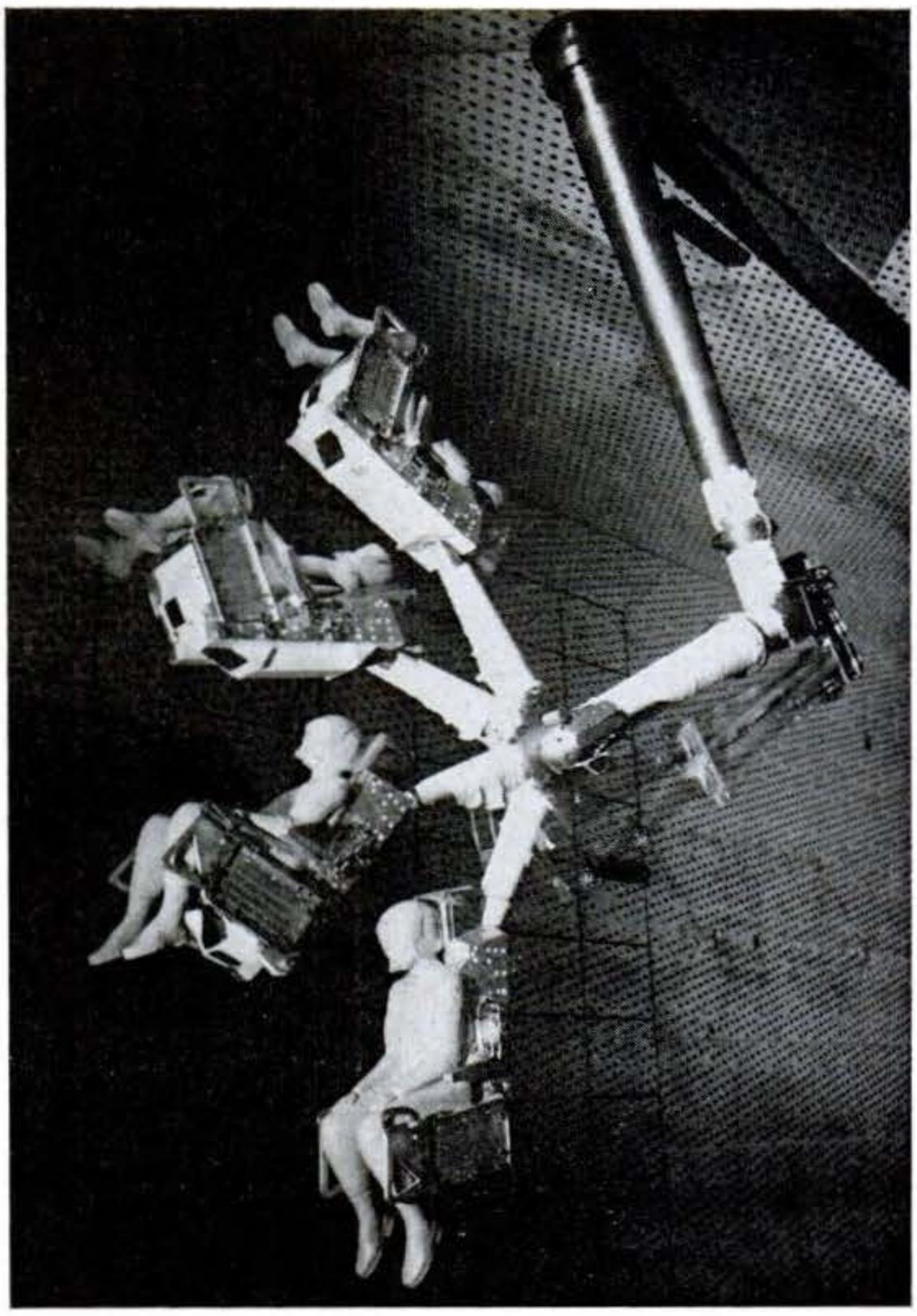


Light meter

Do your plants get enough sun? Find out by exposing a Rite-Lite near the leaves. The light-sensitive film changes color. Match this with a coded list giving the right exposure for your plant. Price: $2 for 12 disposable meters. C.C.P., Box 6895, Cleveland, Ohio 44101.

Dapper Derby

After the Beetle—what? Volkswagen's latest answer is the Derby. This notchback fits between the baby Polo and the Rabbit. The Derby's front-drive power pack has a transverse engine with 40-, 50-, and 60-hp options. The five-seater won't be available here.



Safe trip?

A thrilling new amusement-park ride? No, it's a multiple-exposure photo of the ejection seat for the B-1 bomber. During recent tests in an Air Force wind tunnel, high-pressure air was used to simulate the rockets that will catapult the seat—and its occupant—from the aircraft.

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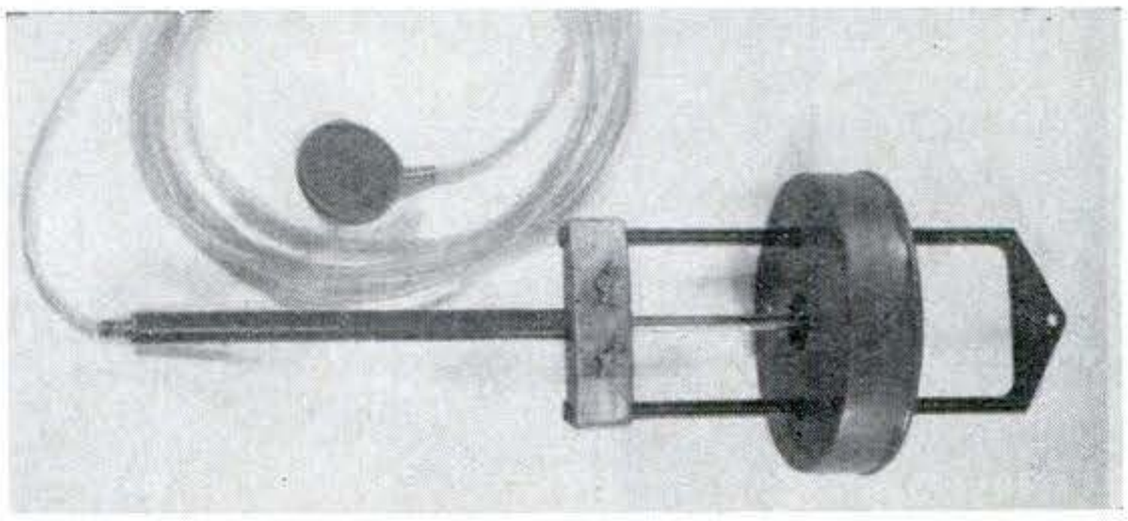
What's New IN BOATING

BY SUSAN RENNER-SMITH

Wave-action pump

Moored near your boat, the Tumbalens bilge pump is actuated by waves or boat movements. A lead weight steadies the pump as the bobbing float moves the piston. The 15-foot hose to the bilge has one-way valves. Nautilus Trading Co., 495 E. Seventh St., Brooklyn, N.Y. 11218. $50.

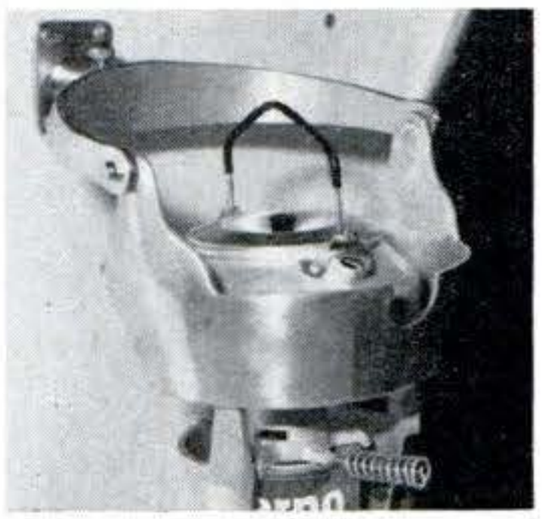


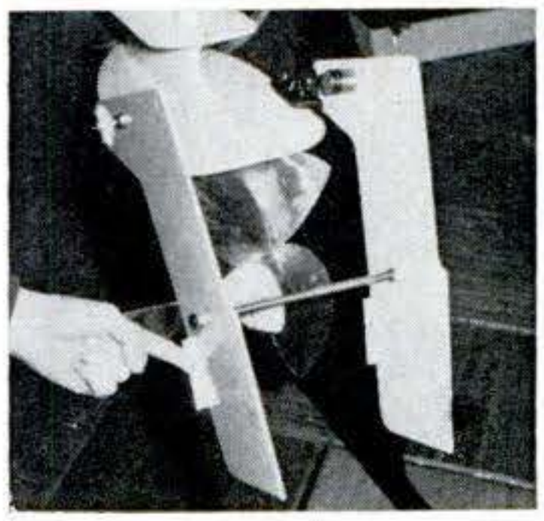
Safer boat

Unique, 4½"-wide aluminum side decks on the Grumman 3.8 (above) cover foam wedges. Running from bow to stern, the vinyl-covered foam extends down to the seats. Its job? To meet the Coast Guard's 1978 flotation requirements. The 12'4"-long aluminum craft is $497.

Quick cooker

For speedy cooking aboard ship, the Sea-Swing stove has a cone-shaped heat intensifier that funnels canned heat directly to the pan's bottom. The gimbaled stove stays level despite boat motion, says the maker (Bremer Mfg. Co., Box 100, Elkhart Lake, Wis. 53020). Price: $36.



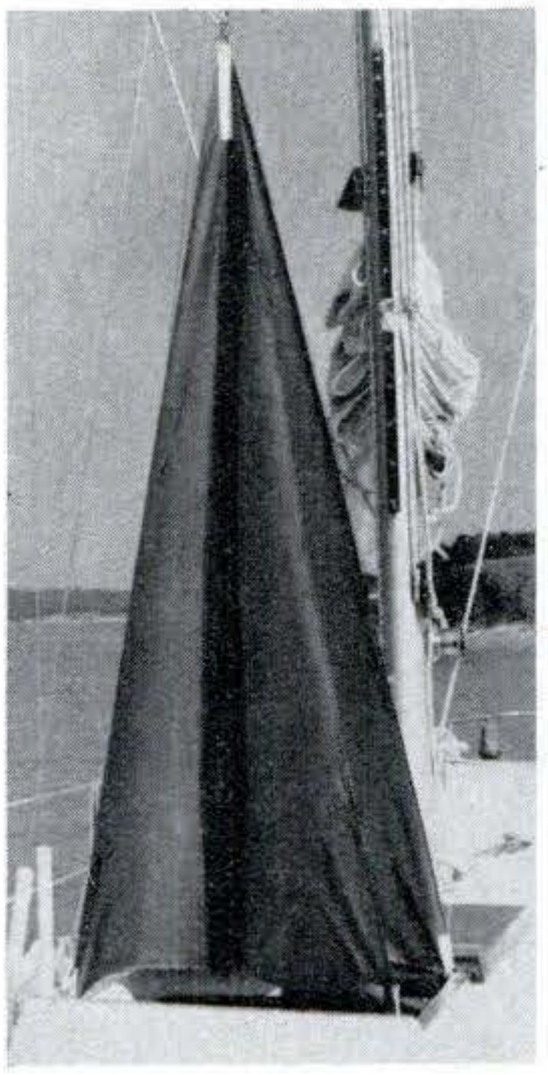


Twin rudder

Add a double rudder to your outboard and you'll get easier steering at low speeds, claims its maker, AB Janforadling (S-640 30, Halleforsnas, Sweden). At cruising speeds, lifting plates on the rudder's edge automatically swing it up into the slipstream to reduce drag.

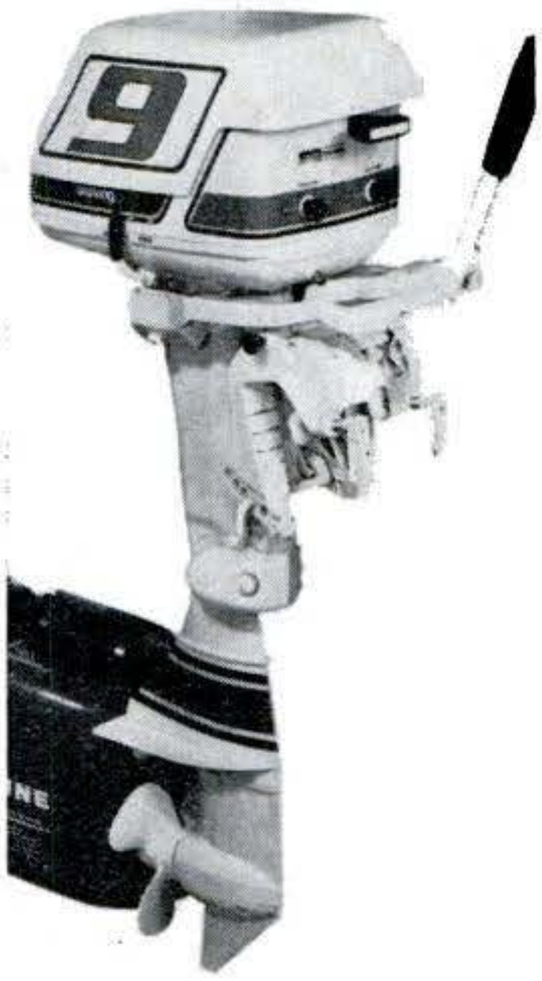
Reliable power

What's the best battery for your trolling motor? The 105-amp/hr Action Pack—largest deep-cycle battery on the market—will power a fishing motor for at least eight hours, says Gould, Inc. For shorter runs, the 80-amp/hr unit shown will last at least four hours. It's $50 at J.C. Penney.



Hatch cooler

Hot and stuffy in your sailboat cabin? The Fourwind vent's triangular panels channel all breezes right down the hatch. Nylon cords fasten the silent wind-catcher to screw-in buttons on the hatch. The folding blue nylon vent is $24 from Shape, Inc., Box 5781, Richardson, Tex. 75080.



Quiet engine

Air-cooled outboards are noisy and rough, right? Not this new 9-hp model, claims Montgomery Ward. A foam-lined engine head and an air-intake silencer help cut noise. To reduce vibration, the steering handle and transom bracket sit on rubber mounts below the engine. $500.

Life-saver

Even with a puncture, the Ethafoam filling of the Imperial Life Vest will keep the wearer afloat, says Gladding Corp. (Box 8277, Station A, Greenville, S.C. 29604). The adjustable, grease-resistant vest has a flat back panel to give freedom of movement. Price: $27.95.

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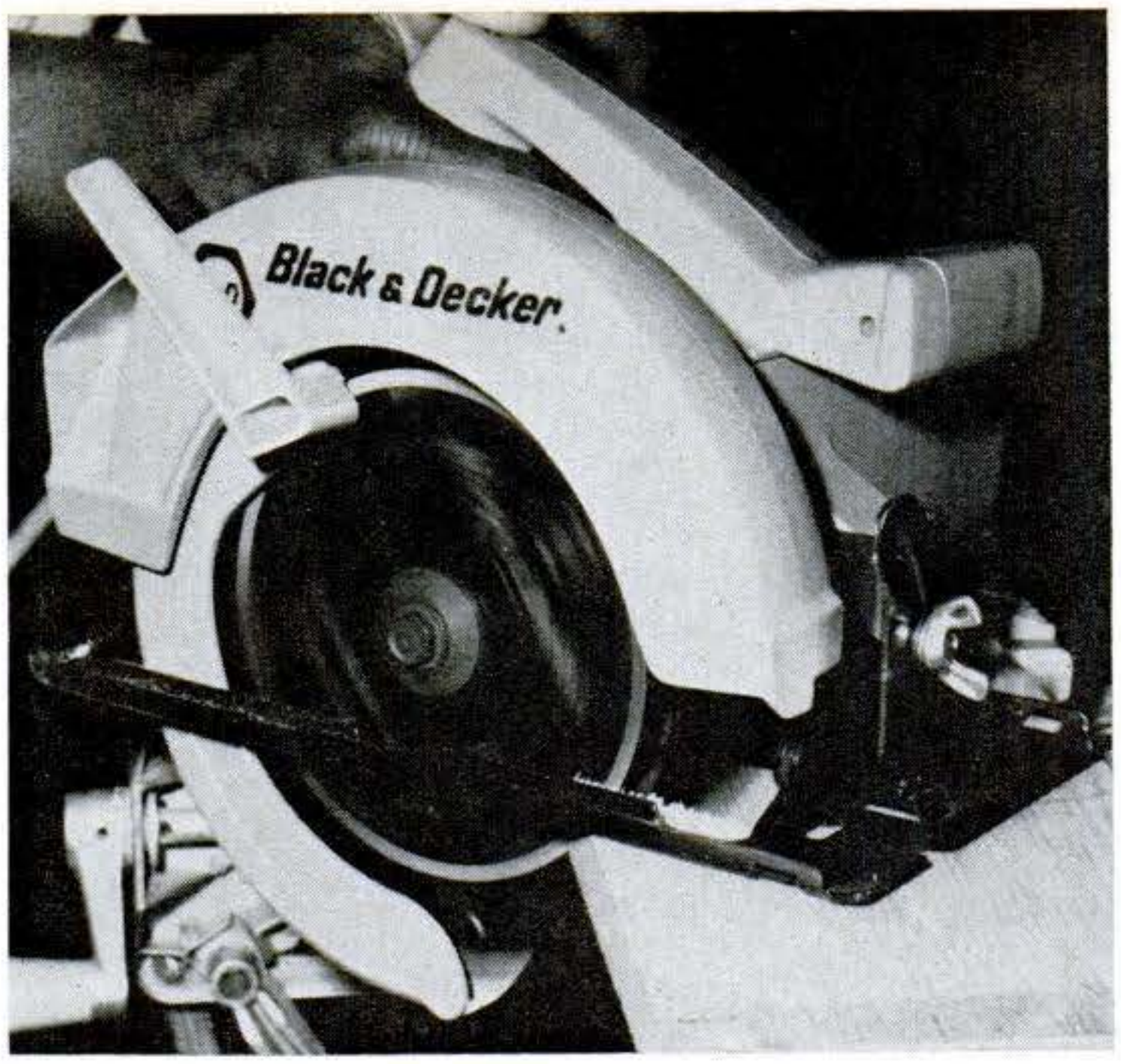
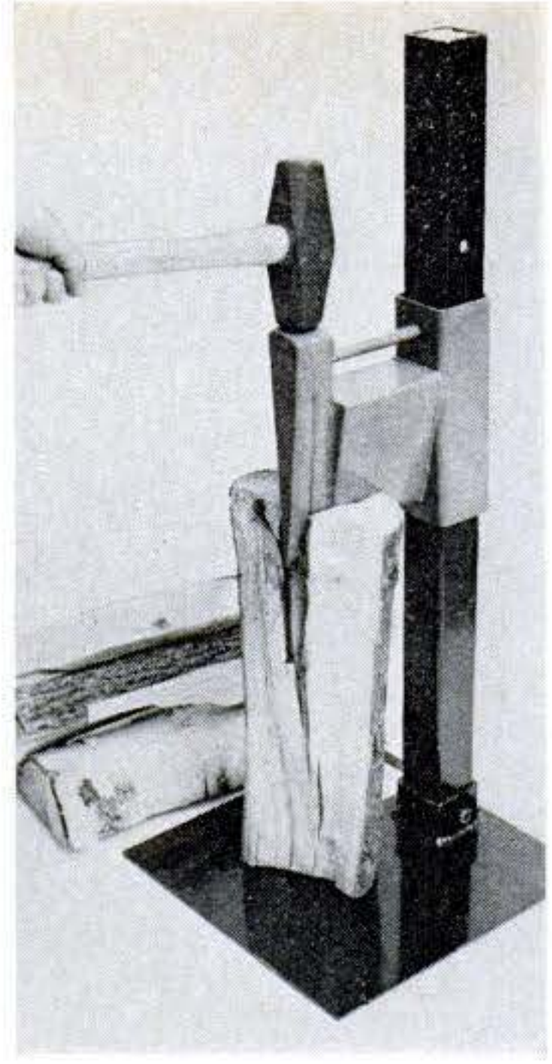
What's New IN TOOLS

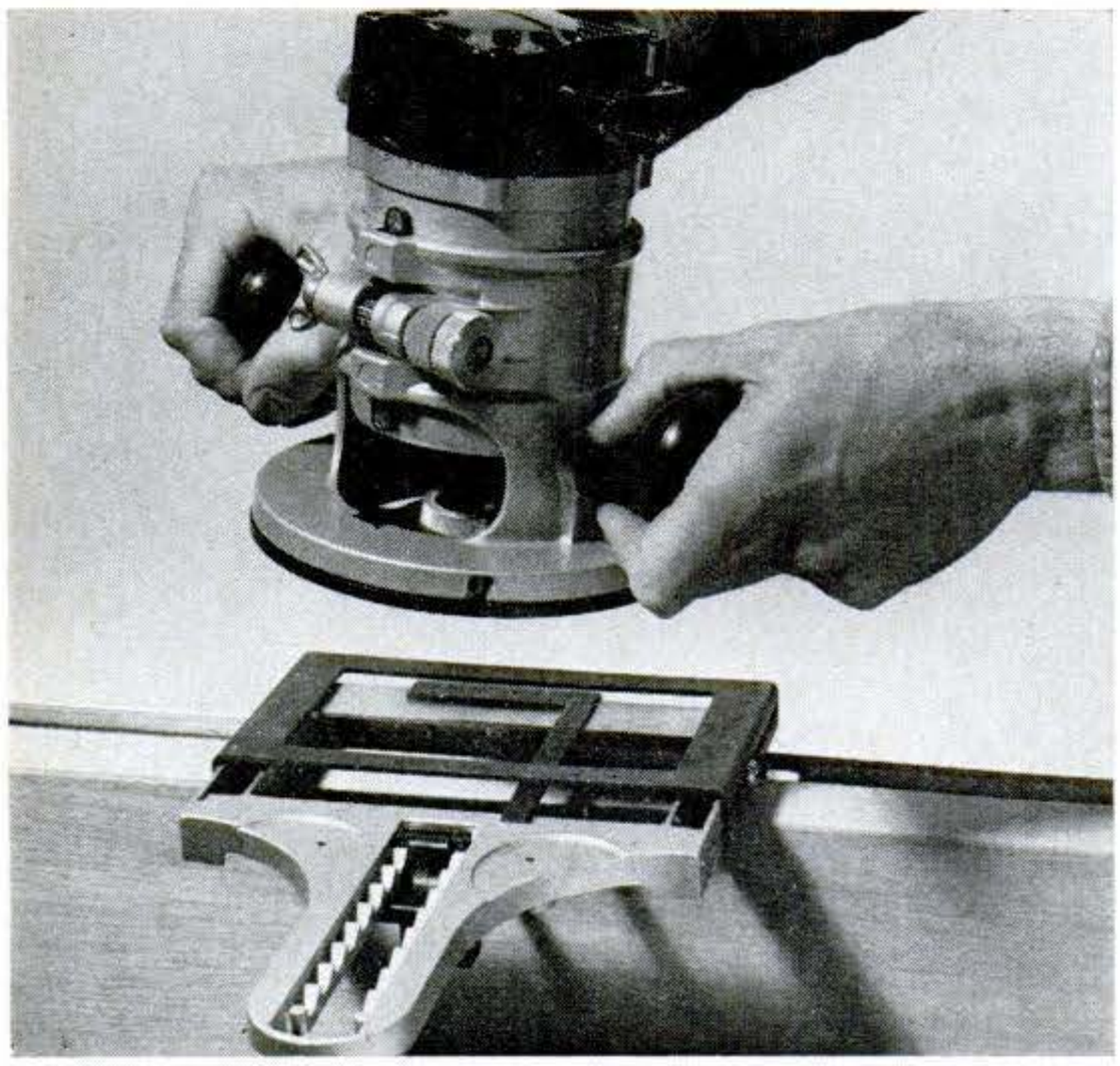
BY R. L. STEPLER



Safer circular

Black & Decker's 7¼" circular saw has double insulation, wraparound steel shoe, power lock-off button, and two handles for better control and safer operation. Other specs: 2-7/16" cutting depth at 90°, 1⅞" at 45°; weight: 10 lbs.; 1⅓-hp motor; price: $30.



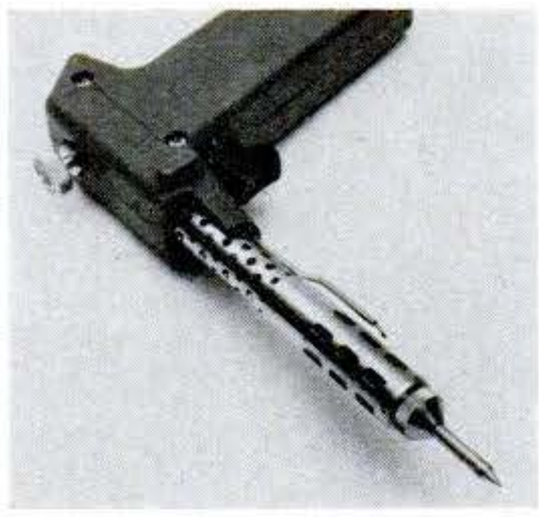


Routing template

Can't get the hang of hanging doors? Try Sears' butt-hinge routing template. It lets you accurately rout hinge mortises on both door and jamb. After setup, mortise size and spacing are automatic. The template works on a variety of door thicknesses and hinges. Price: $4.99.

Woodsplitter

The Jiffy Woodsplitter lets you split logs with a sledgehammer. The device's guided wedge adjusts for logs up to 30" long, allows safe, hands-off operation. The woodsplitter is $89.95 from Oak Grove Enterprises, Box 47A, Foristell, Mo. 63348.



Soldering gun

Catalytic conversion heats the tip of this soldering gun: butane lighter fluid reacts with a precious metal to generate heat without flame or electricity. One filling gives hours of operation, says the maker. It's $49.95 from Rocky Mountain Products, Box 8666, Salt Lake City 84108.

Electromagnetic retriever

Drop something in a hard-to-reach, hard-to-see place? Nose in Plucker's flexible tube; then pull the trigger to activate a bright light and a shielded electromagnet to locate and retrieve metal parts. Three D batteries power it; $10.95 buys it. From Middle America Products 6000 Cornhusker, Lincoln, Neb. 68507.

Plastic hose clamps

Snap-it nylon hose clamps won't damage soft rubber or plastic hose and are resistant to corrosion, says the maker. A twist spreads the one-piece clamps for installation; a built-in ratchet lets you lock 'em in place with ordinary pliers. The clamps come in 10 standard sizes from ½" to 2-3/16". KGL Co., 100 E. Irving Park Rd., Roselle, Ill. 60172.

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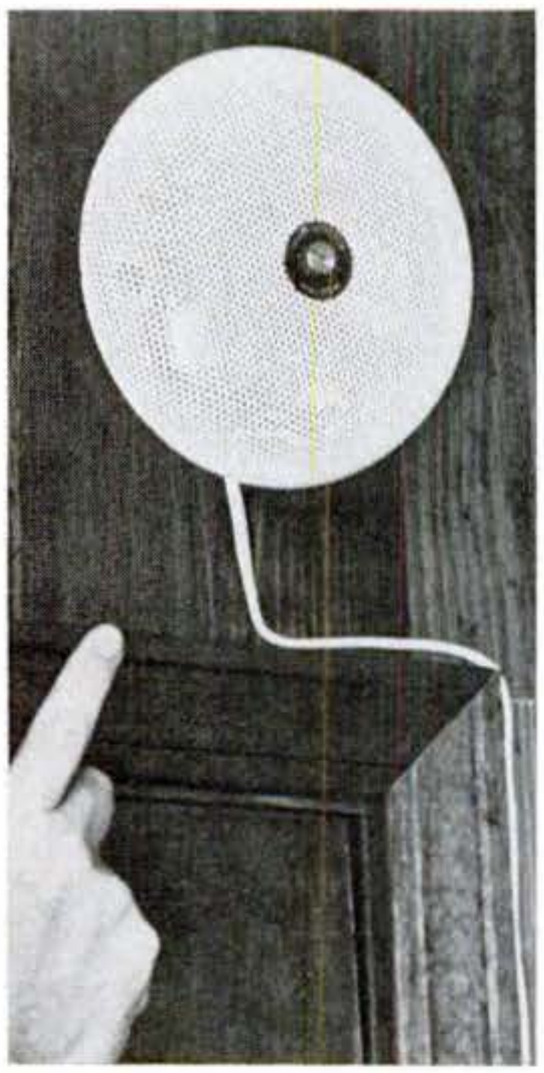
What's New IN HOME IMPROVEMENT

BY R. L. STEPLER

Whirlpool in redwood

The rub in this tub is Jacuzzi's whirlpool hydro massage. Three or four whirlpool heads provide the action. Sequoia Whirlpool Spas are offered in three sizes: 5′ dia. by 3′ deep; 5′ dia. by 4′ deep; and 6′ dia. by 4′ deep. Prices range from $1660 to $2460 with either gas or electric heater. Sold in kit form, the redwood tanks can be sunken, semisunken, or freestanding. Jacuzzi Whirlpool Bath, 298 N. Wiget Lane, Walnut Creek, Calif. 94596.



Smoke alarm

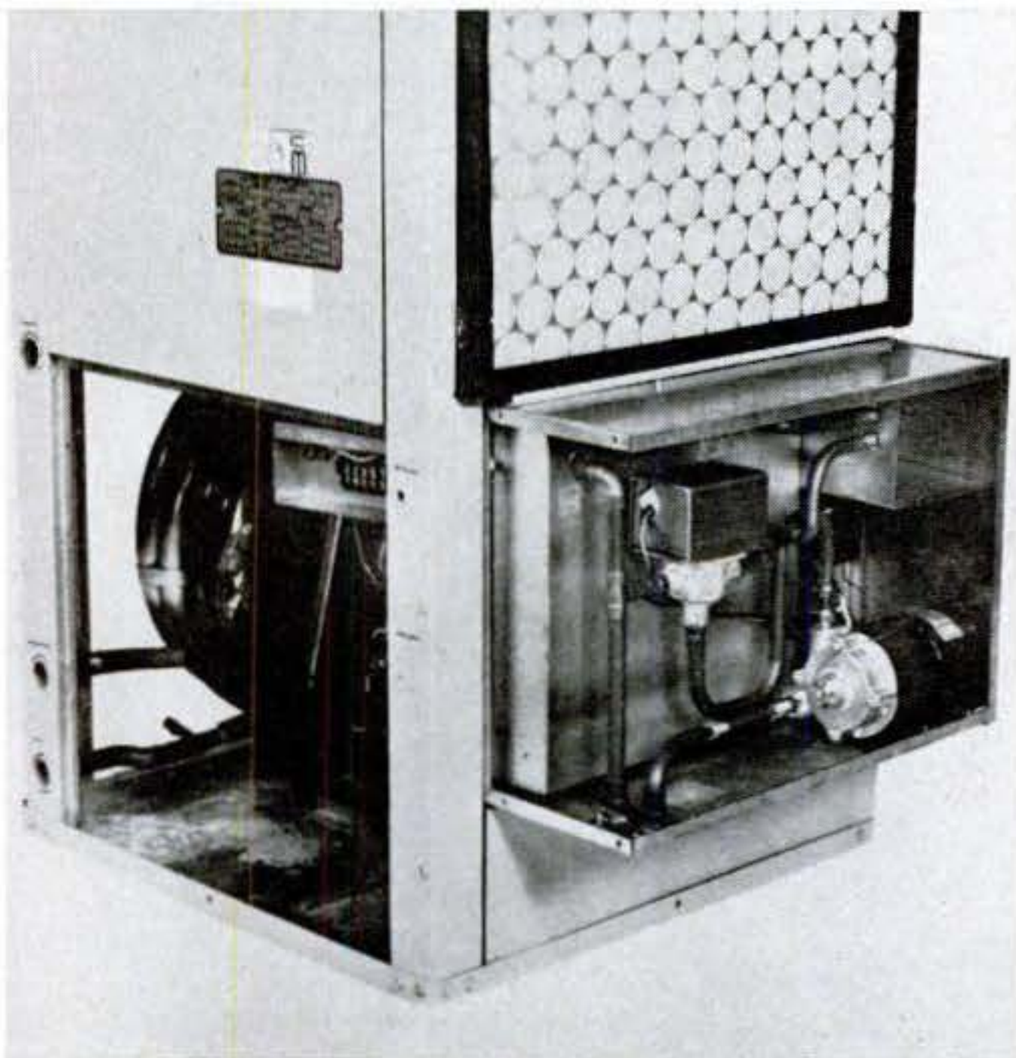
Waldom's SD-1 photoelectric smoke detector sounds its own alarm. A built-in transmitter spreads the warning via optional indoor and outdoor alarms. A beacon lamp tells you it's working; a trouble alarm tells you it's not. Price: $80. Waldom, 4625 W. 53 St., Chicago, Ill.

Plastic hinge

It won't ever squeak, loosen, or wear out. That's what the maker of the Zenith thermoplastic nylon door hinge says. Want to find out? A pair of the 3½″ by 2⅞″ hinges costs 75¢ from Zenith Marketing & Sales, 4734 Broom, San Antonio, Tex. 78217.

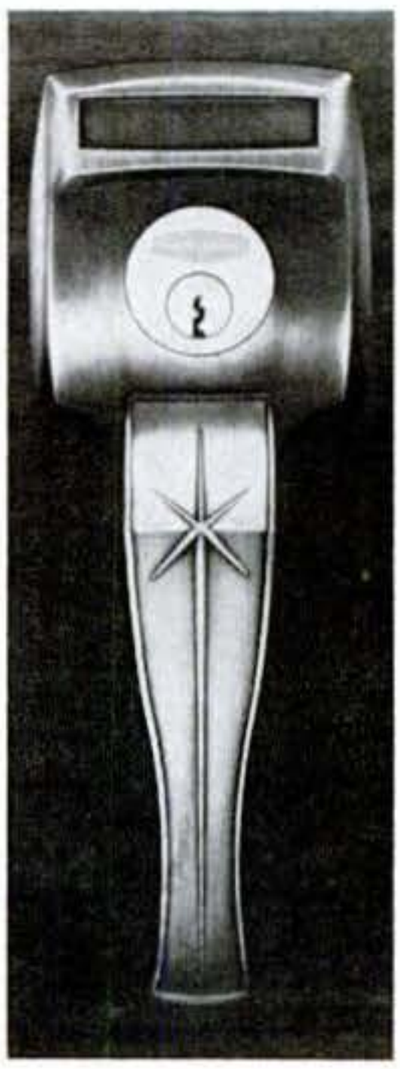
Safe from fire

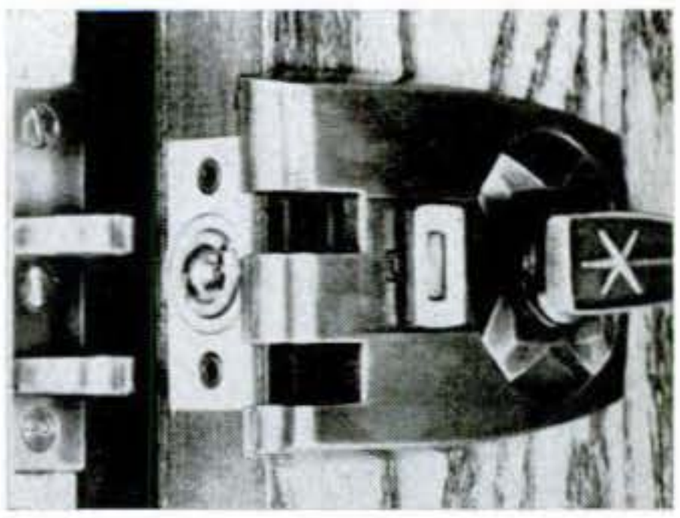
Your vital papers should be safe in the Sentry Survivor, a 13″ by 8″ by 17″ concrete-insulated safe that's fire-tested to 1700° F for one hour. Inside dimensions: 9⅜″ by 4½″ by 12¾″. Price: $49.95. Maker: John D. Brush & Co., 900 Linden Ave., Rochester, N.Y. 14625.



Hot-water-bill reducer

If you heat and cool your home with a heat pump, Friedrich says you can save 30 percent on your domestic hot-water bill. How? By installing a Friedrich hot-water generator: the 6″-by-12¼″-by-17″ unit mounts on your heat pump to extract heat from the compressor discharge. A small pump in the device circulates water from your existing hot-water heater, which acts as backup, to the heat exchanger. A thermostat controls temperature. The hot-water generator adapts to Friedrich as well as other makes of heat pumps. For more information, write Friedrich, 4200 N. Pan Am Exp., San Antonio, Tex.





Door lock

No drilling or mortising with this new dead-bolt lock: Super Guard Lock II replaces standard key-in-knob locks. All you need is a screwdriver. Outside (left), there's an integral handle and cylinder guard. Inside (above), there's a lever-operated dead bolt with lock-out switch. Price: $29.95. Williamson, Box 503, Cherry Hill, N.J. 08003.

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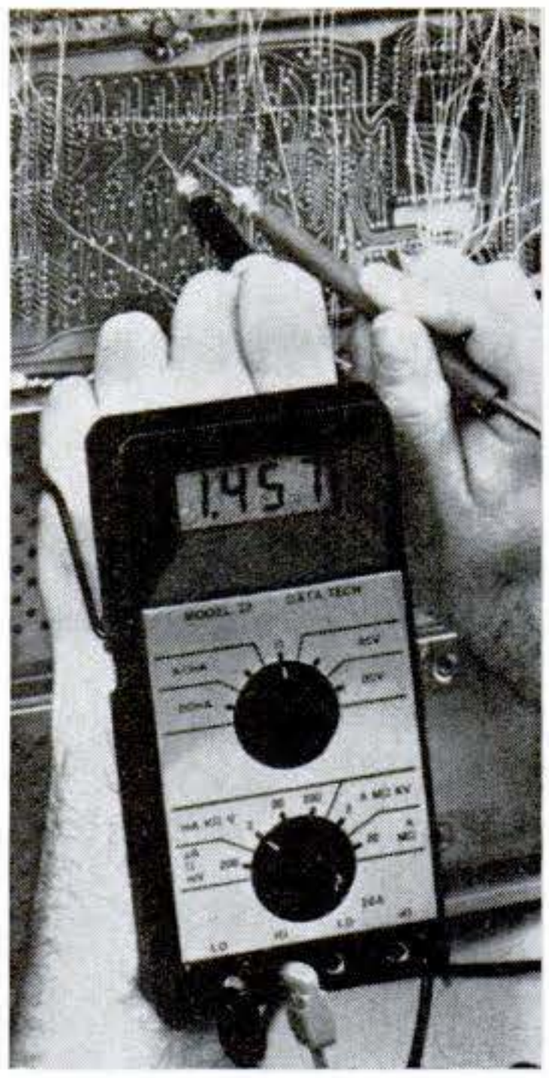
What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS

Colorful whips

CB antennas are designed to electrically match your CB rig. These are designed to match your car as well. They come in nine colors, and you can mix or match them with their separate bases and your car. Made by Maycom, 1134 W. John Beers Rd., Stevensville, Mich. 49127. Price: $24.70.

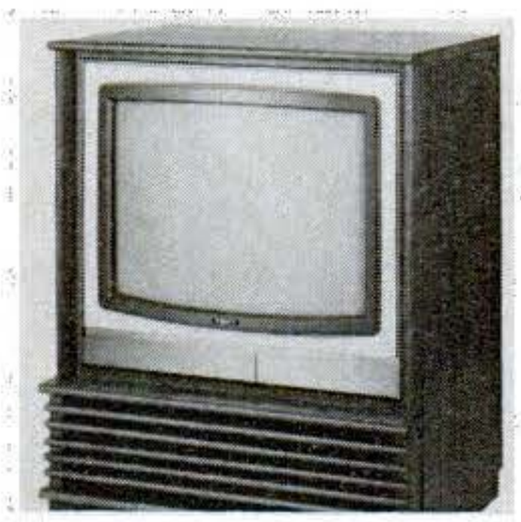


200-hour tester

Need digital accuracy in a hand-held multimeter? This new 3½-digit model 22 is good to 0.1 percent and runs for 200 hours on one set of batteries. Rechargeables are available. It's $234 from Data Tech, 2700 South Fairview, Santa Ana, Calif. 92704.

Auto scanner

Enter any 10 of 6000 public-service frequencies, and this new Bearcat 210 will search them for you automatically. The digital display shows the channel and frequency being monitored as it scans. No crystals are needed, and it works on AC or DC. The Bearcat 210 is $349.95.

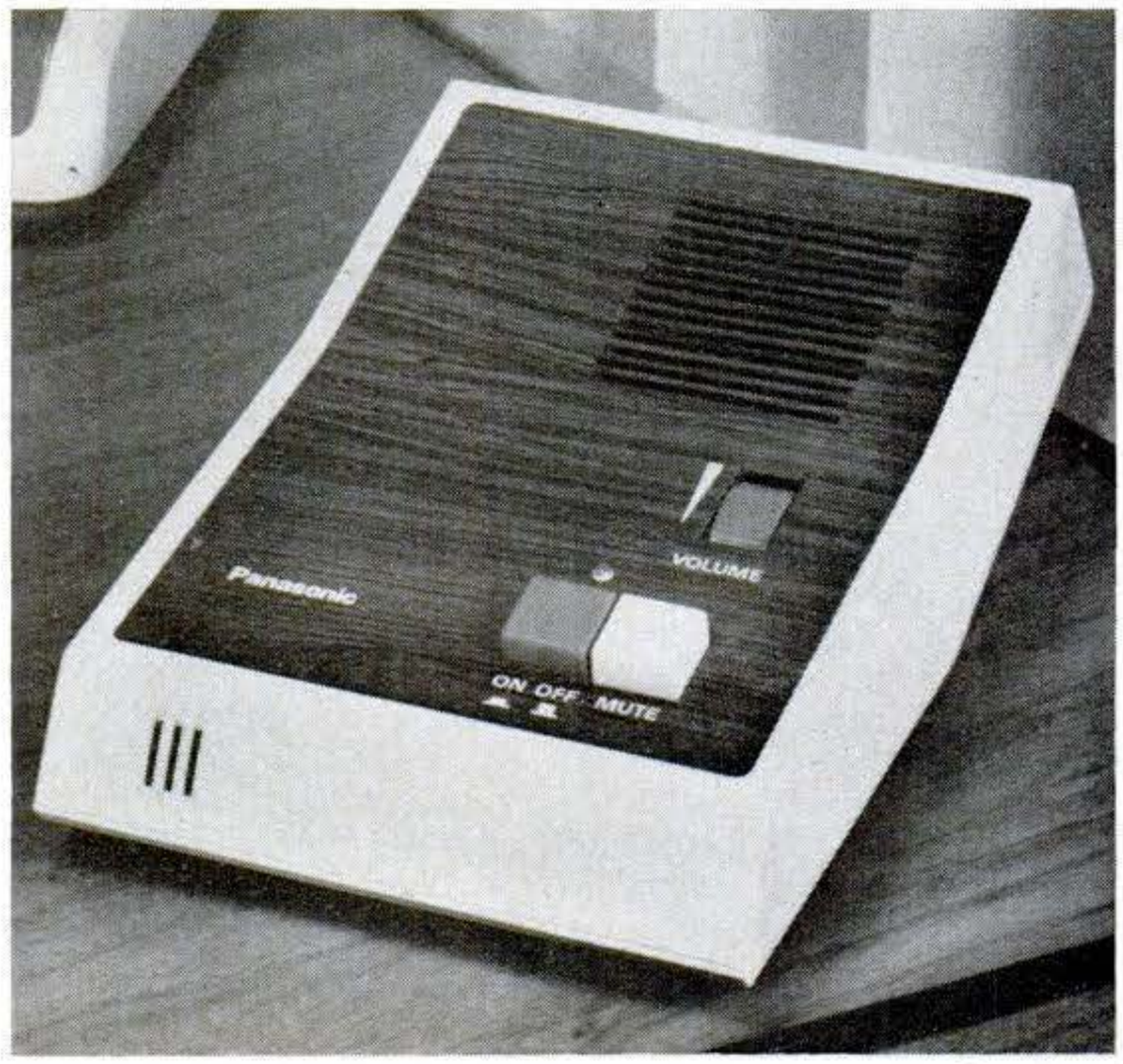


Giant screen

You can put away the ruler if you're trying to measure the screen size of this new Sony Trinitron TV—try a yardstick. The experimental receiver has a 32-inch-diagonal picture—a great leap beyond the 25-inch maximum. Sony has no current plans to bring it into the U.S.

CB checker

Connected between your CB rig and antenna, this constant-performance indicator checks to ensure that transmittter power is above 3.5 watts and SWR is better than 1.2 to 1. If not, indicators alert you to possible trouble. It's $19.95. Maker: CiBco, 3801 Willow Springs, Okla. City, Okla.



Desk phone

Hit the button on this new speakerphone from Panasonic, and you've answered the call—it's a hands-free telephone unit for your desk. It has automatic gain control and muting key, operates on phone-line current—no AC or battery voltage required. Price: $200.

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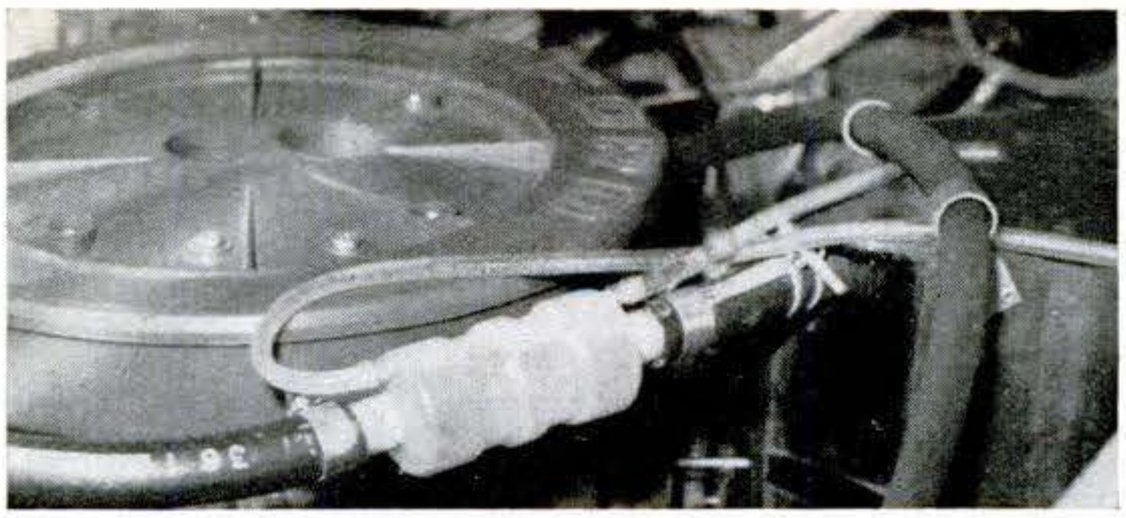
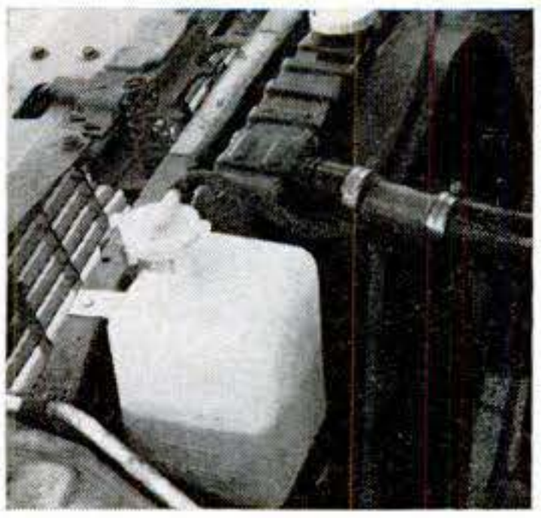
What's New
FOR YOUR CAR
BY RICH CEPPOS

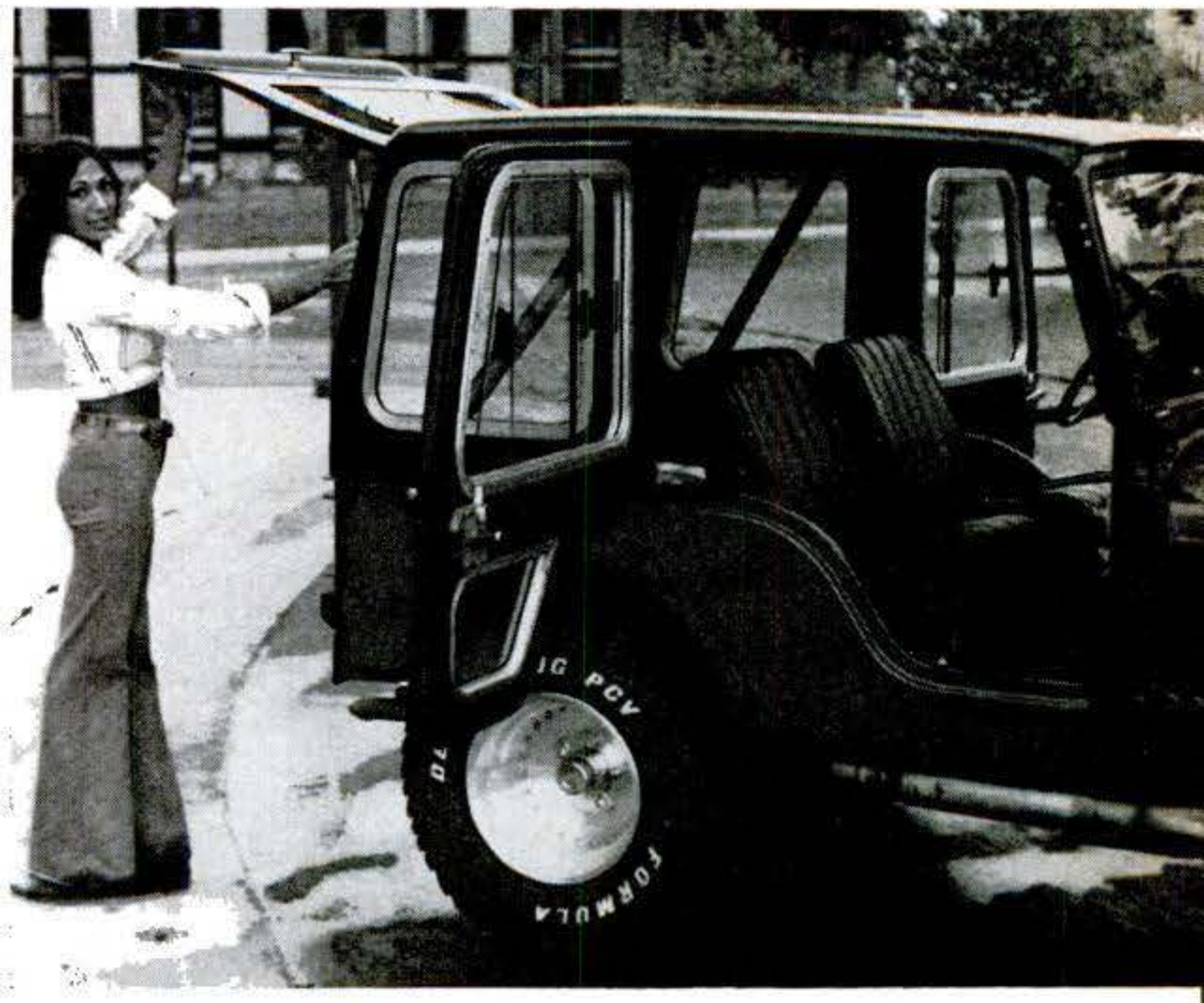


Wash fluid heater
A heat exchanger spliced into the heater hose warms windshield-washer fluid to help dissolve road tar and speed melting snow and ice. Capacity of heater provides enough fluid for five seconds. Li-Lo Ltd., Albert Dr., Sheerwater Estate, Woking, Surrey, England.



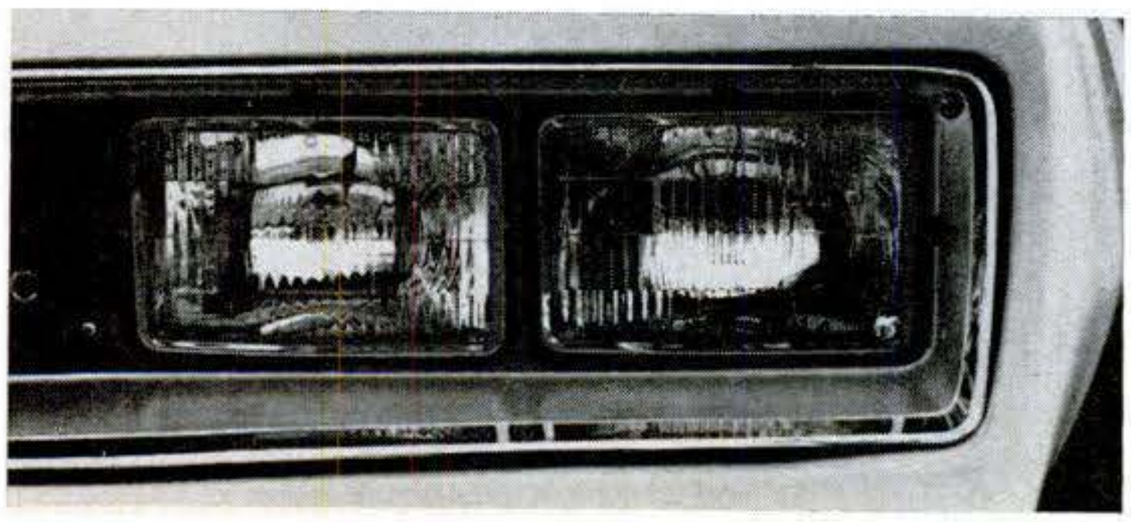
Coolant kit
Convert your cooling system to sealed operation? You can with the Top Performer Coolant Recovery System. Its Sight Tube, at the radiator inlet, lets you check for bubbles —which the maker says indicate a leak. It's $10 from Performance Products, Inc., Box 27407, Tempe, Ariz.

Body-filler packs
Need a small amount of body filler? These packs contain 4 oz. of polyester body filler. Mix in the cream hardener and you've got enough to fill minor dents. Eight packs of Duro filler and a tube of hardener cost $6.95. Woodhill Chemical, Box 7183, Cleveland, Ohio 44128.



Cover-up for foul-weather 4WD driving
For the man looking for a roof to insulate a CJ-5 for rainy or cold-weather use, the fiberglass Tank Top offers an alternative to fabric or steel tops. It features a large glass area, a flip-up tailgate, and a window in the lower part of the passenger-side door to help navigation in tight quarters. Door and tailgate windows slide open for ventilation, and the doors can be removed easily or locked open against the body. It weighs 220 lb.; the maker claims it can be installed and removed faster than any fabric top. It's $845 from Design Factory, Box 4130, Overland Park, Kan. 66204.

Van roof
The full-length, fiberglass Cruisin' Top increases driver head room by 5" and rear head room by 9". The flat rear section is an observation platform. It comes in kit form with windows and headliner installed. Price is $695 from Carpetbagger, 1100 Pioneer Way, El Cajon, Calif. 92020.



High-power heads
Upgrade your automobile's rectangular headlights by plugging in these Hella H4 quartz-halogen units. They replace the low beams, but contain both low and superpowerful high beams. Distributed by MG Mitten, 44 S. Chester, Pasadena, Calif. 91106. Price: $46.90 per pair.

Air cleaner
With the Fram air-cleaner kit on your four-cylinder Vega, you replace only the filter cartridge—rather than the entire unit—when required. It's $19.87 (1-bbl. carb) or $21.87 (2-bbl. carb). Maker: Fram Corp., 105 Pawtucket Ave., Providence, R.I. 02916.

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What it's like to build and use **your own home computer**

They compute, memorize, and display just about anything—all from kits you build yourself

By WILLIAM J. HAWKINS

Push the right keys on the SWT TV terminal and the National Multiplex tape recorder dumps old programs or records new ones from the IMSAI 8080.

I didn't send Christmas cards last year; my homemade computer did the job for me. And I no longer need a personal phonebook: This box of blinking lights gives me any name, address, or phone number I want instantly, just for the asking. Mathematics? Give it the problem —old math or new, difficult or easy —and the answer appears on a TV screen without hesitation.

Sound great? It is, but a word of caution: Assembling a computer kit takes time—lots of it. And, the final product is not like anything I've built before. With kit stereos and TV's, my work was finished when I soldered the last resistor in place. When I put together the computer, my job was just beginning.

Furthermore, that basic computer kit doesn't come with all the accessories you need to make it do practical work. Want to put information into the computer? You'll need a keyboard to do it. Want to get answers when you ask questions? You must add a TV terminal. You want an answer on paper? Throw in a printer. And, of course, if you want the computer to memorize or store anything, you'll also need an optional memory and a

MITS 680b computer and a Micon miniature TV terminal instantly display recipes, phone numbers, addresses, and other records on a small TV screen.

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tape recorder. These are all extras. If you think they're necessary, you're absolutely right—and that's one reason a home computer system takes so much time to build. Just when you think you're finished, you discover you need something else.

As a novice, I started by building a kit designed primarily for the beginner—the MITS 680b, a new but relatively small computer. If you've ever built an electronic kit before, you know what to expect: empty printed circuit boards, plastic bags filled with components, and an instruction manual detailing your moves for the next—in this case—15 hours.

The instructions (documentation as it's known in computer circles) are well done. Most of the components mount on two printed circuit boards that are then simply plugged together. Detailed drawings show how each component should be oriented—what you'd expect from a beginner's kit.

What MITS doesn't assume, however, is that you're also a beginning computer operator. I had trouble hooking up the jumpers that are required during the final steps of construction (they select certain conditions under which the computer will operate). Before you can do this, you have to answer questions like: What "baud rate" will you be running? How many "stop bits" do you require? Will you be using RS-232, TTY current loop, or baudot interfaces? I not only didn't know the answers to these questions; I didn't even understand them.

Fortunately, there are a lot of people willing to help. I went to a local Computer Store, one of the sales outlets for MITS, and posed my questions to one of the staff. His answer: "Oh, don't feel so bad, many beginners get stuck on these. All you're doing is setting up the hardware bit structure for the peripheral interfaced to the serial I/O port."

I understood the part about not feeling bad. But the rest of his answer made me feel worse. I found out quickly that people involved with kit computers are willing to be helpful. The problem is that they speak a different language—computerese—and it takes specifically detailed questions to get an answer in English. The translation goes like this: The jumpers told the computer what type of equipment ("peripherals"—teletype, TV terminal, printer) will be connected

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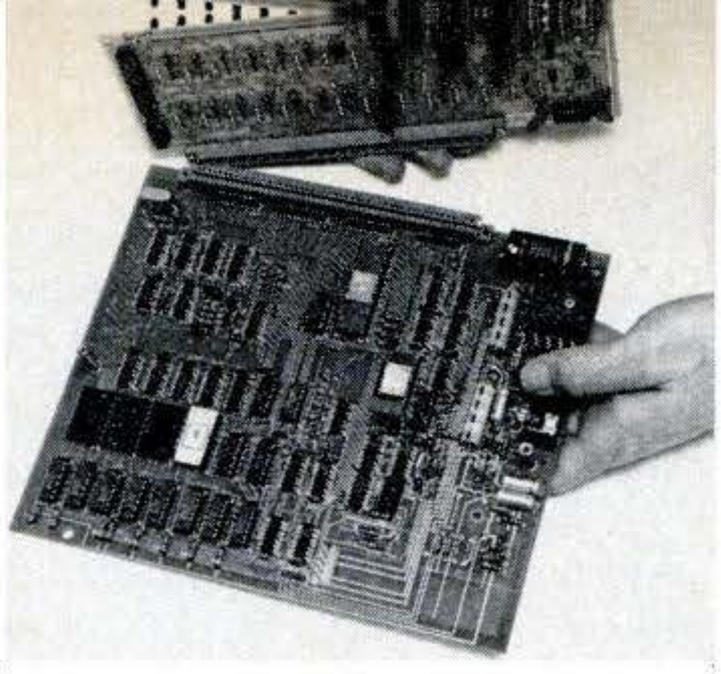
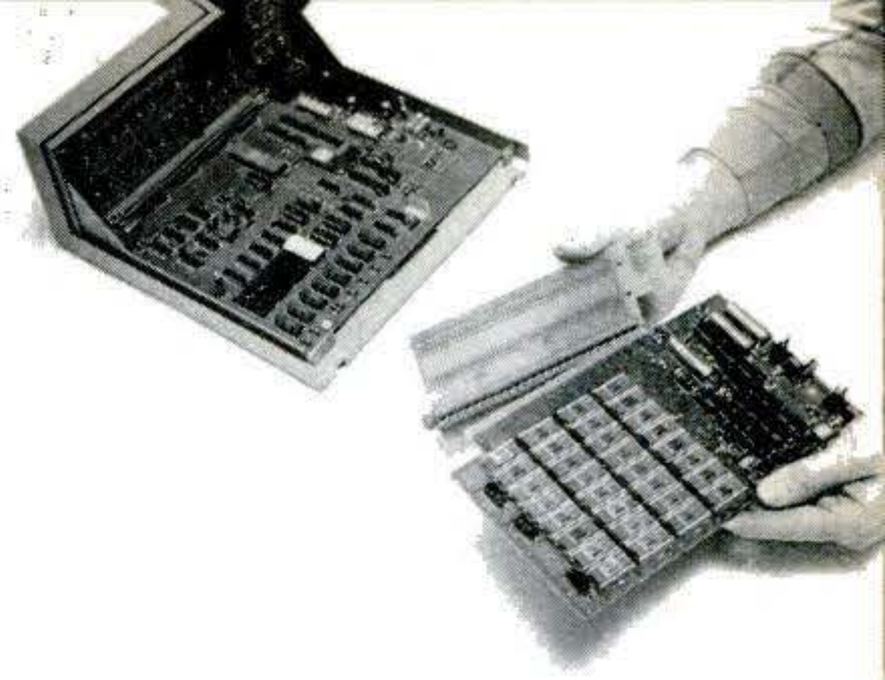
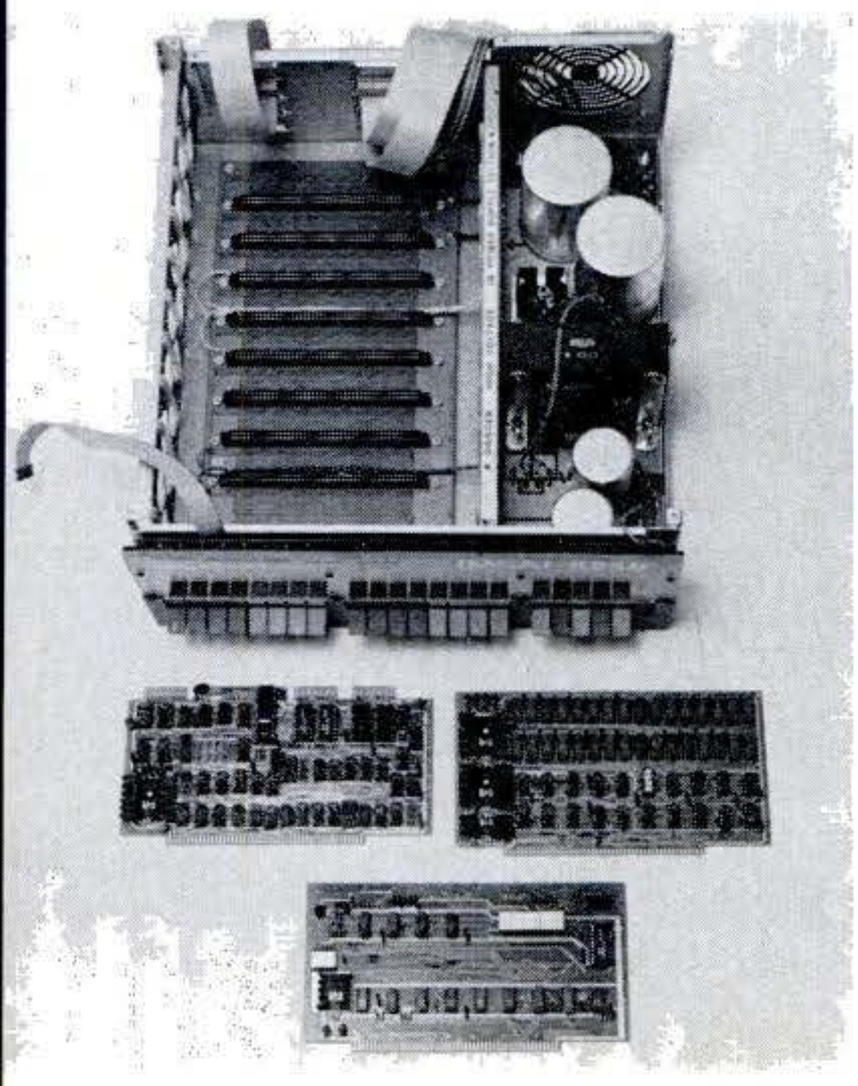
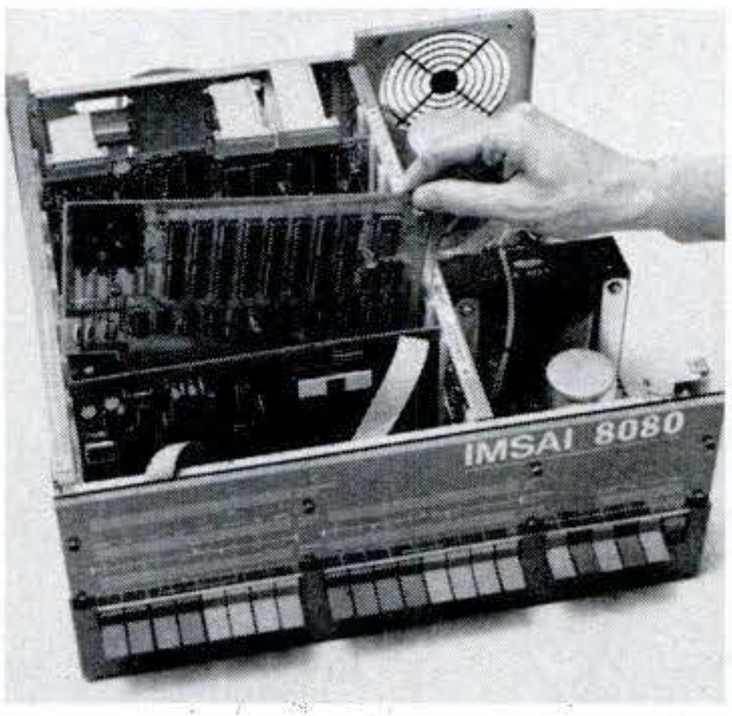
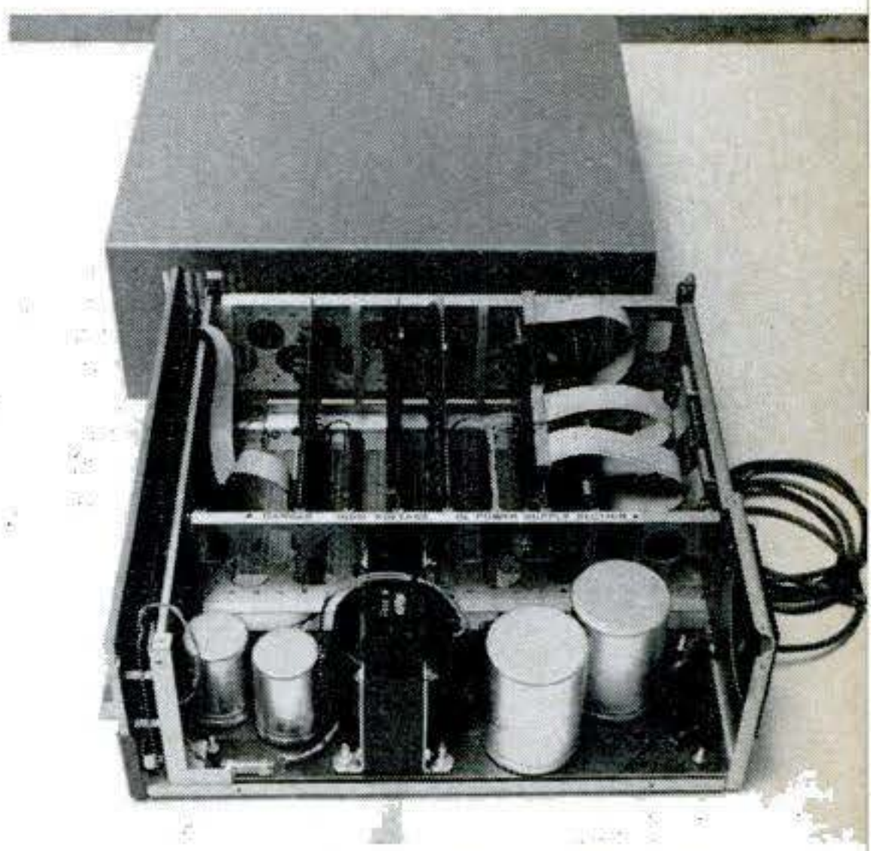




The MITS 680b is well designed, and ideal for the beginner. Basic system is built on two printed-circuit boards—the front panel and main "mother" board—that merely plug together before chassis is installed. Optional memory boards (more than one can be added) plug into expander card, which mates with socket on mother board. Rear panel, with power supply and peripheral connector, is then attached to mother board with two connectors.







IMSAI computer has heavy-duty (28 amp) supply to power up to 22 optional boards that plug into its main-frame mother board. You can use IMSAI's options like the 4k memory and I/O board (at left), or use other boards like the ECT 8k memory (above). Flat ribbon connectors lace inside of system; they're for front-panel connections to microprocessor board and peripheral connectors.

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(interfaced) to its output (port). Knowing this, the computer spits out information (bits) in the right code (serial RS-232, stop bits) and at the right speed (baud rate). I have to admit that computerese is catchy—like the drawl of CB-radio operators. It wasn't long before I was interfacing, TTY'ing, and stop-bitting with the rest of them—it just takes a little practice.

It works—now what?

Over these hurdles, the 680b went together smoothly. When I turned on the power, its 27 LED's indicated life. But, in order to do anything, I now had to learn programming. After about two hours of studying the books and playing with the front-panel toggle switches, I was able to add two and two successfully (and they said I was wasting my time!). The answer doesn't come out as a "4," however. Instead an LED glowed to represent its binary equivalent. It was a success, but not much to show the family.

In order to enter and retrieve any information from the computer in a practical way, another "option" is needed. For me, it was the TV Terminal from Southwest Technical Products. The terminal is actually two things in one box that share some of the same circuitry. It's a keyboard (like a typewriter's) for entering data, and it's a bunch of integrated circuits that change the binary information from the computer into a video signal that can be displayed on a standard black-and-white TV screen. Data are printed out on the screen of the set (which you must also supply).

What's in the kit

With my soldering iron not yet cold, I began building the terminal kit, but it was far from what I expected. The kit comes with three instructions, basically: Put all the parts together; turn it on; and—if it doesn't work—troubleshoot it yourself or send it back to the factory.

Along with the components, you get a schematic diagram, a few rough sketches and a technical circuit description: It's obviously not designed for the beginning electronics-kit builder. But its low price—$275 versus a minimum of $500 for other units—makes it quite attractive. And, since it is designed for the hobbyist/experimenter, it has a number of circuits available to you for special functions—push a button to clear the screen, for example. Of course, you can just stick to the sketches and hook it up normally. But as I found out, its low price meant a minimum of hardware as well; the cabinet you see does not come with the kit. It's another option you'll need from Enclosure Dynamics for $47.95.

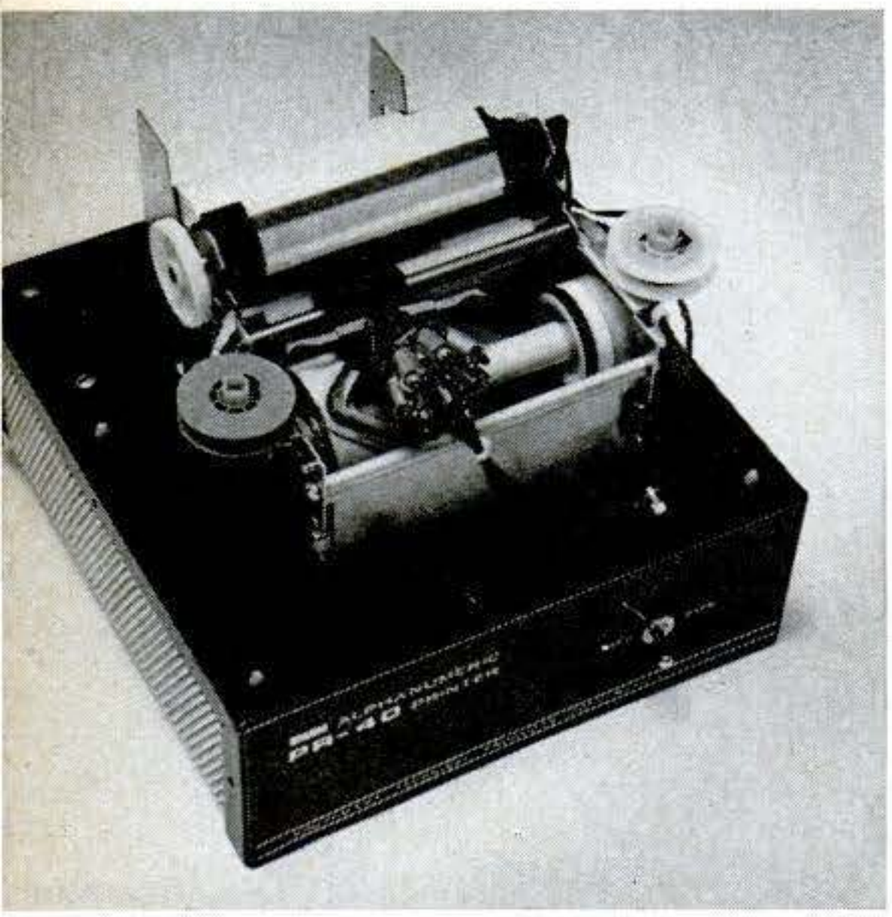
I could now enter and retrieve data rather quickly using a PROM (programmable read-only memory), which was included with the MITS computer. The PROM is actually just an integrated circuit that mounts in the computer. Stored inside it is a small program that automatically teaches the computer to input and output information to the TV terminal. Without a PROM, the computer would simply ignore the fact that you're pushing buttons on the keyboard—it would not have been programmed to look for incoming information.

I began with very simple programs (a step up from 2+2) and gradually built up as I learned more machine instructions. (There are 72 of them, plus seven different modes of use.) One program I wrote simply allowed me to type in my name. Once in the computer, it was automatically used in a sentence (like those computerized "We're sorry to inform you, *Mr. Hawkins,* that you are late with your payment" letters). The sentence the computer came up with was to be random and supposedly funny to impress onlookers and relatives over for the evening. For my first memo, I typed in my name. The computer responded with "What?" across the face of the TV screen.

Unfortunately, "what?" was not in my program.

Not to be outdone, I then typed in "Do it." The computer answered with "Leave me alone"—also not in the program.

I have concluded that an error in the original program had the computer searching old, previously stored information (at least that's what I keep telling myself). Fact is, as I found out, errors in the program can do much more than just give erroneous answers; they could "blow" the program. One wrong instruction out of perhaps several hundred you've taken hours to put into the computer might cause a total wipeout of the memory banks. When this happens (and it happened often to me), you've got three choices: pull the plug out of spite, begin typing all over again, or use a tape recorder.



Printer kit from Southwest uses fine wires to print matrix of dots on paper. Pattern of the dots forms characters.

TV terminal from Southwest Technical is built on five boards that plug in or connect to sixth mother board (output is video). Case is not included, requiring your own handiwork or a prefab like this one from Enclosure Dynamics.

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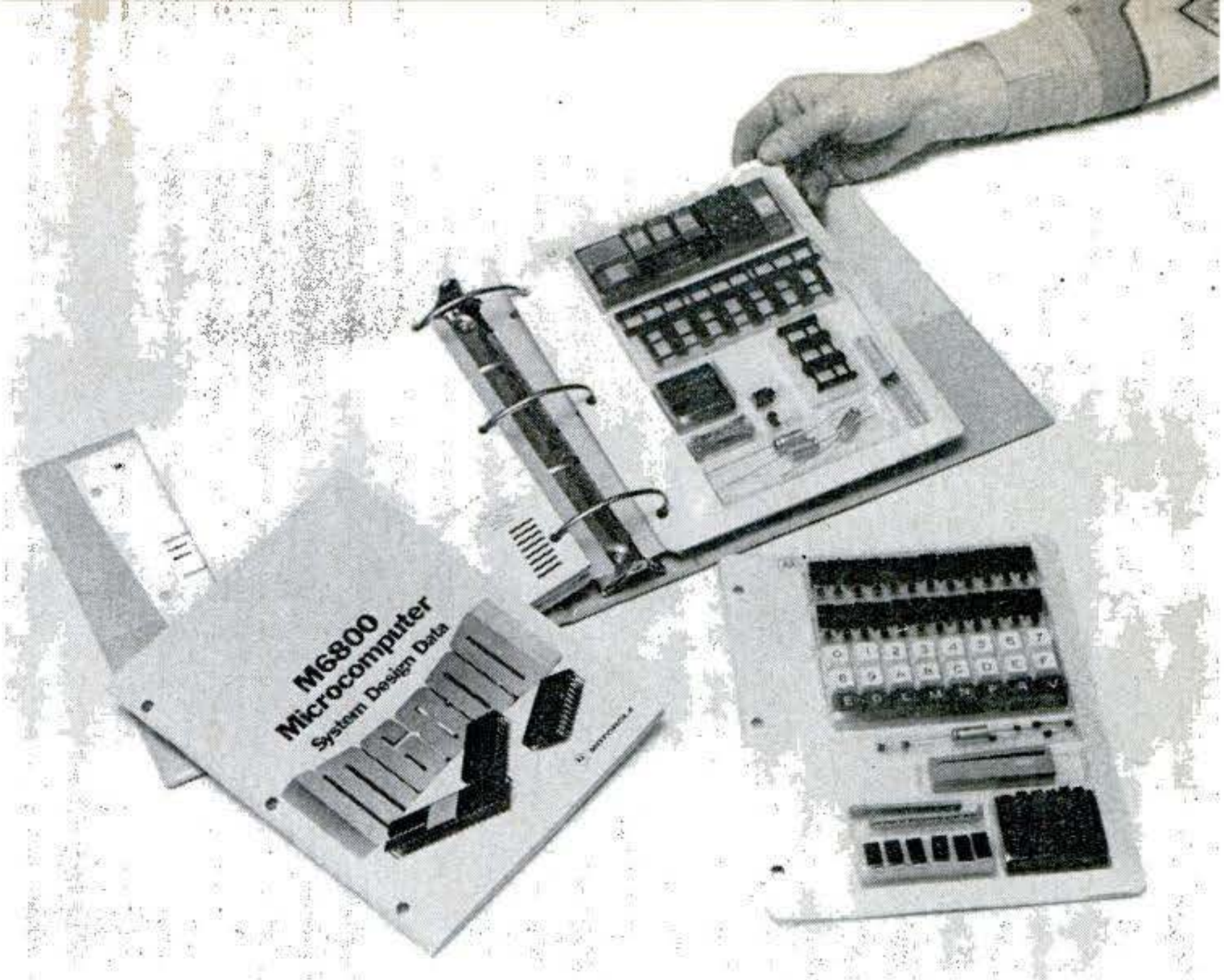
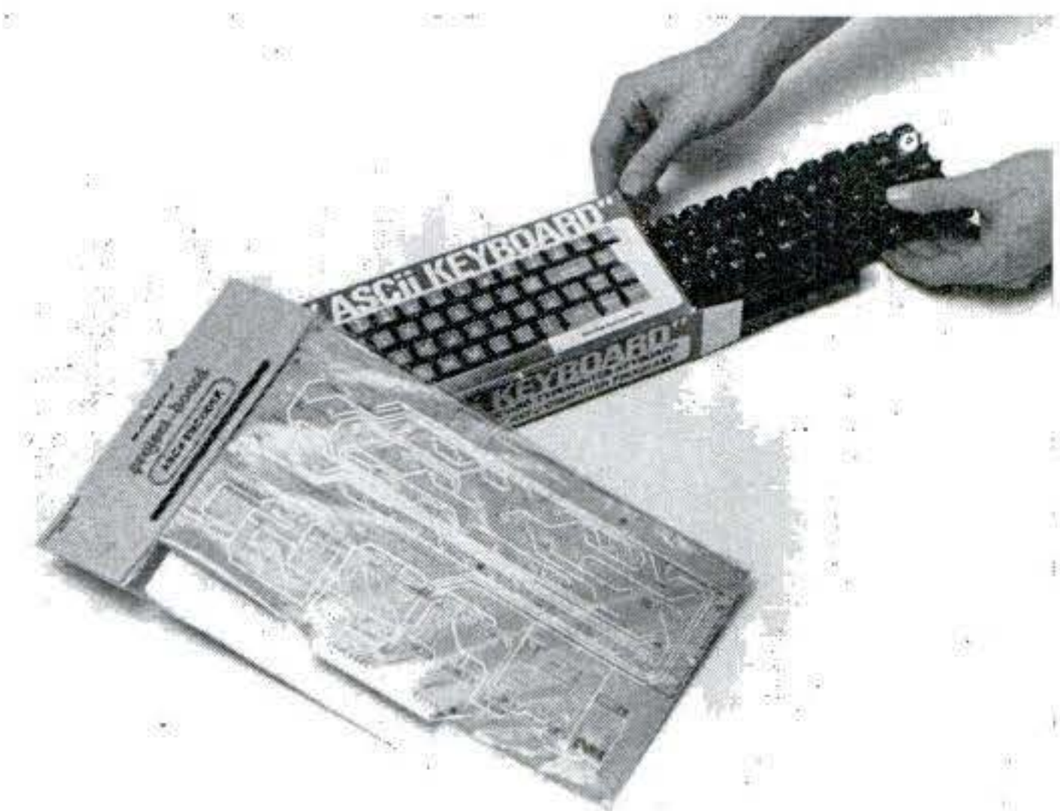
With a tape recorder you can record all the information in the computer before you run,—and possibly blow—the program. There are different ways, or formats for taping; I chose a National Multiplex Digital recorder because of its high speed. A few hundred steps of a program can be put back into the computer in seconds. Even though the recorder does not come in kit form, I logged quite a few more hours trying to make the computer accept it as an input source (the MITS 680b is not designed for it).

The recorder does save you a lot of time, but, since you no longer fear blowing large programs, you begin to write even larger ones. Now you face another dilemma: running out of memory space. Add to your shopping list an optional memory board from MITS. Once built, it plugs into the 680b giving you an additional 16,384 bytes (16k) of storage, and another $685 to your original $466 purchase price. (The 680b will accept up to three extra memory boards, increasing its storage capacity to 49k.)





New products in the home-computer hobby field include this computer-in-a-book (above) from Motorola. Based on the 6800 microprocessor, it comes with its own keyboard. Data are displayed on digital readouts mounted on one of the two boards. You must add a five-volt power supply. Radio Shack will be adding to this keyboard (left) later with an entire computer kit.

It doesn't stop

After you've run through programs that count, search, or flash special messages across the screen, the novelty begins to wear off and you want to do more practical things. I decided to computerize our Christmas-card list; if successful, I would prove to the family that all my work had been worthwhile.

So I used another kit—a Southwest Technical printer—to make labels with names of all the relatives I tried to impress earlier. One problem, though, they weren't impressed—the system stuttered. Mrs. Dallas became Mrs. DDallas and it was long after Christmas before I discovered my wiring error.

(For you computer enthusiasts already into this, you can use the Southwest printer on a serial port if you use the Southwest terminal. Connect the print-data lines to the keyboard-input-data lines on the terminal mother board, which is not now used because of the UART board. Connect the input strobe to IC 5 pin 3 on the UART board; not the strobe line, which caused the occasional double printing. It works, but you'll have to add a software time delay after a carriage return.)

At this point, you probably feel I was then well on my way to a complete system. It's true, I was, but as I got further into the hardware and software, I also became aware of different computers: bigger, more powerful, able to control more peripherals than ever. Before I could hit the "run" button, I was back in the shop building an IMSAI 8080 computer.

Although it's a hobby computer, the IMSAI is comparable to an industrial-size system. It will perform 78 separate instructions, control up to 64 different peripherals (together, or one at a time), and accept up to 65k of memory.

This is far from a beginner's computer kit. The instruction manual is written as though you've built a big computer before, and you have a full working knowledge of programming. Component layouts and board construction are given in steps, but much of the final assembly is left to your imagination. After about 30 hours of work, however, you'll have a computer that will do nearly anything—once you add in the options.

With a big-league computer like the IMSAI, most everything is an option: memory boards, input-output boards, PROM boards. After you've built the optional input-output (I/O) board, for example, you'll need the optional $18 cable to connect it to the rear panel. But, when you buy one of these boards, it may take the place of separate pieces of hardware ordinarily extra for a smaller computer. For example, the new IMSAI I/O allows you to connect three separate peripherals to the computer, control them, and use a standard audio tape recorder for recording and playing back programs.

Another plus is the fact that many other manufacturers make special boards designed to plug into the IMSAI. Besides the 4k memory made by IMSAI, for example, I built another 8k board from Electronic Control Technology and just plugged it in, for a total of 12k of memory. National Multiplex makes another board that gives automatic

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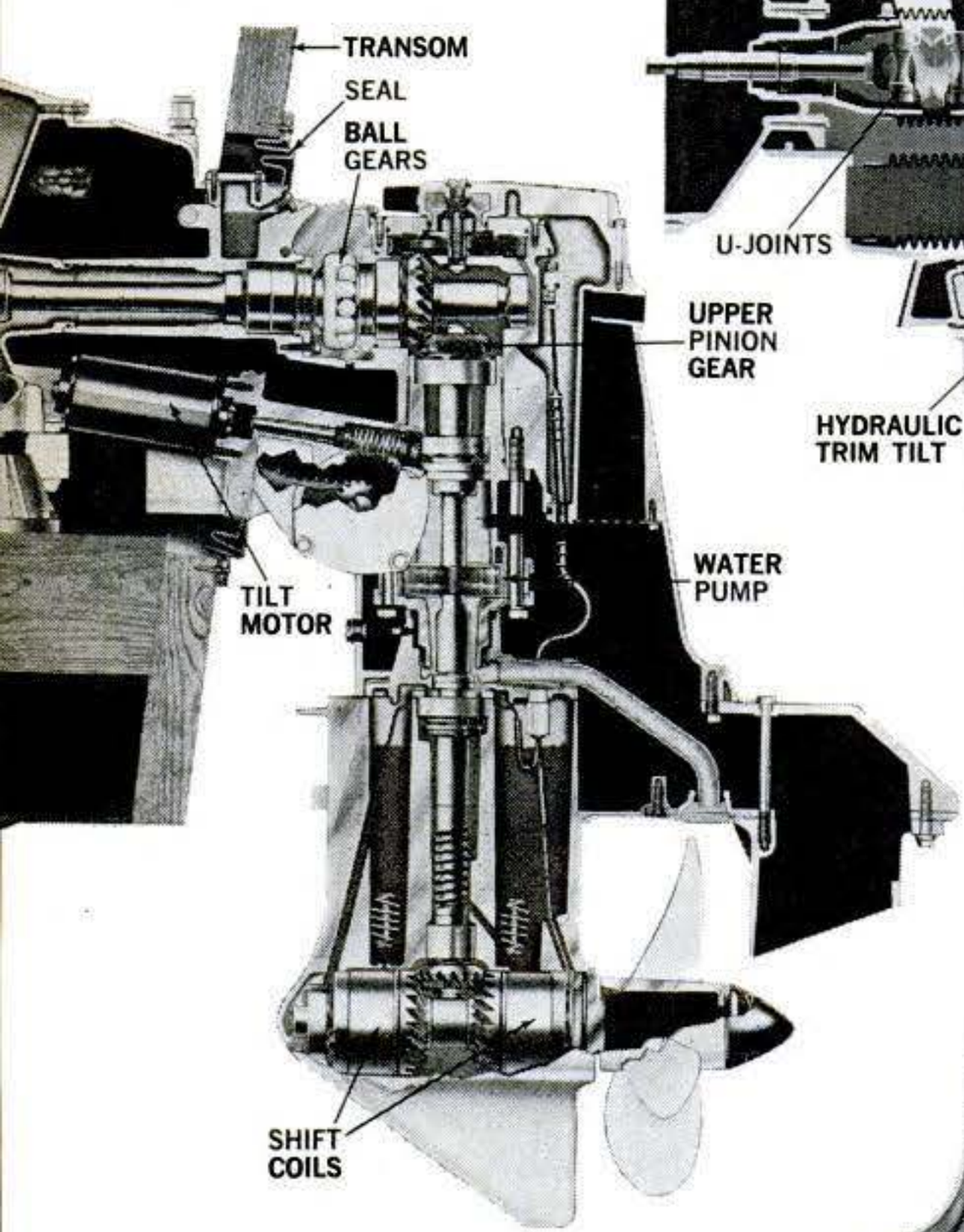
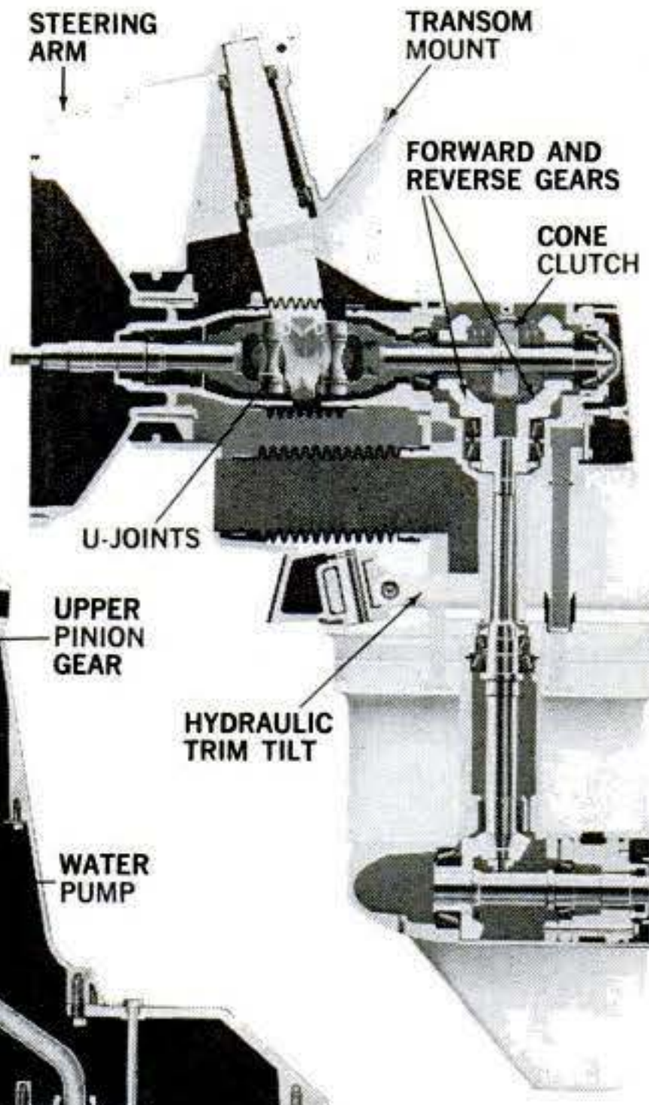
Inside the new **stern drives**

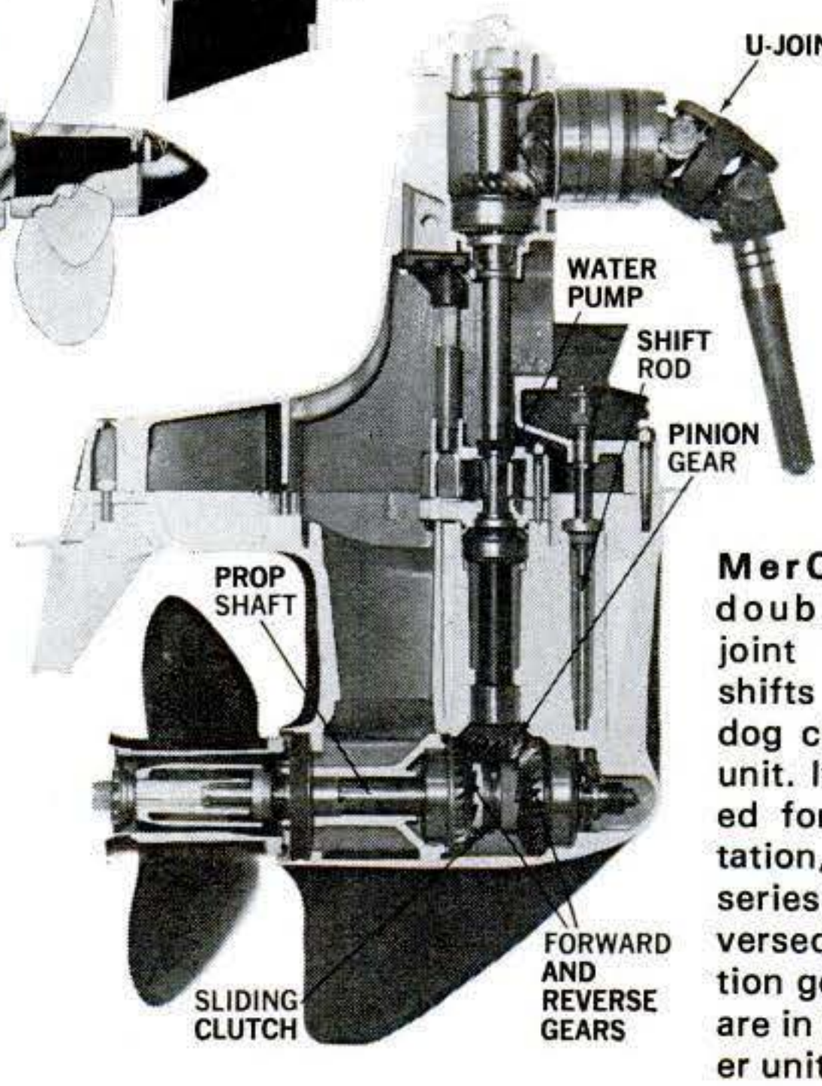
What makes the I/O's unique



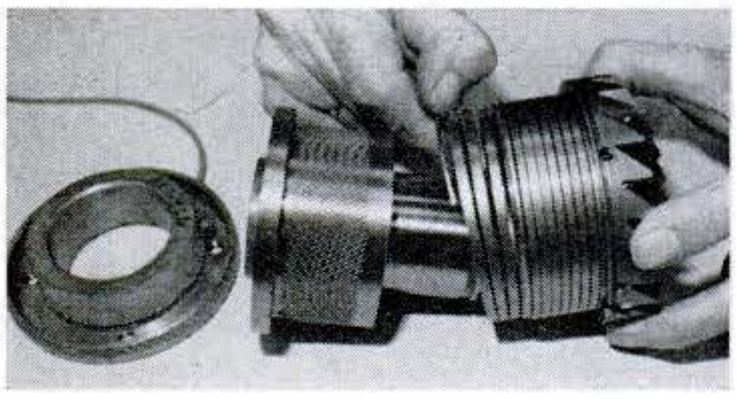
OMC's I/O is firmly attached to engine, floats freely in transom diaphragm seal, and engine tilts to provide trim. Main tilt lift is done with electrical worm drive. Shifting takes place in lower unit by electrically operated solenoids and spring/wrap clutch.

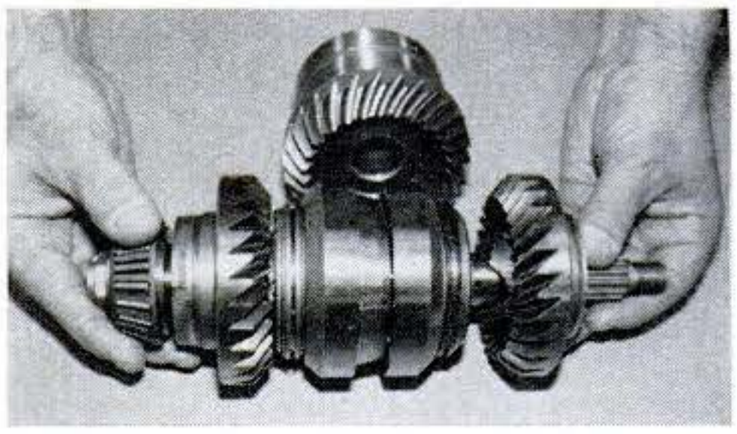


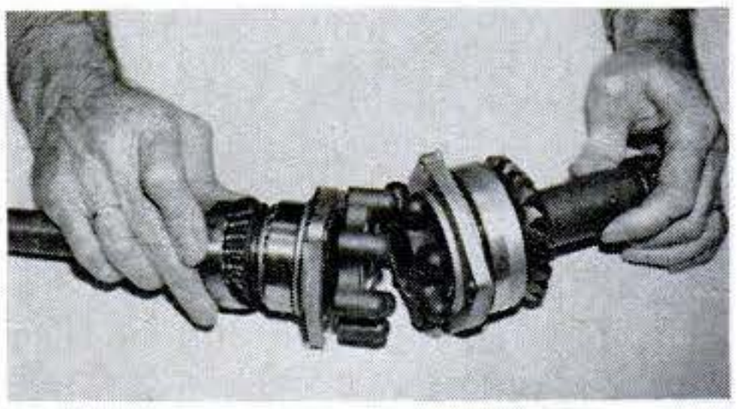
Chrysler stern drive is noted for clean, rugged simplicity. Doubled taper bearings take reverse rotation; self-energizing cone clutch is at upper end on horizontal shaft. Lube needs are less stringent than for other I/O's.

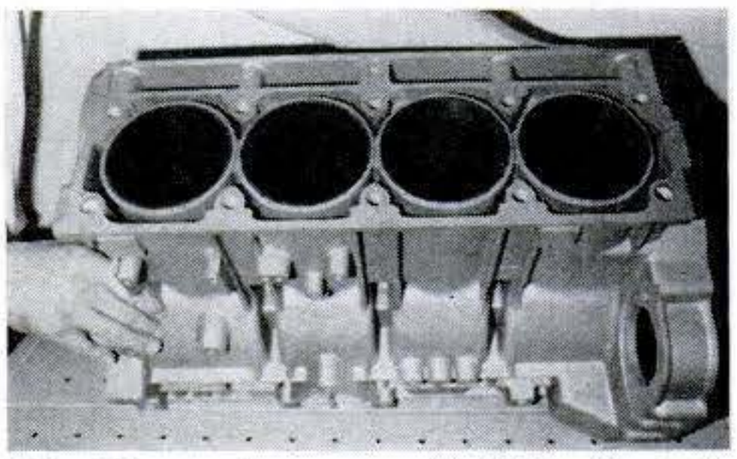


MerCruiser has double universal-joint input shaft, shifts with rugged dog clutch in lower unit. It's not intended for opposite rotation, but TR model series can be reversed since reduction gear and clutch are in boat, and lower unit has one gear.









Significant features of I/O's include (top photo) the solenoid (left) and spring/wrap clutch (right) that act to make OMC shift smooth. Chrysler cone clutch (second from top) uses double-end cone to engage forward or reverse gear. Ramp, seen inside gear (right), boosts engagement force. In OMC flex-drive, novel ball joint (second from bottom) takes place of U-joint. New 470 aluminum crankcase for MerCruiser (bottom) reduces weight.

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Versatile and rugged I/O's bristle with clever engineering innovations

By E. F. LINDSLEY

Call them stern drives, inboard/outboards, or simply I/O's. These compact tiltable, steerable packages, tucked under the stern of a boat and looking like the bottom of an outboard, are a bagful of nifty engineering tricks.

And the '77 models incorporate the most advanced engineering ever. Four companies offer them: Chrysler, Mercury Marine, Outboard Marine, and Volvo. All four makers do basically the same thing with their engines: make horsepower go around corners to get from engine to propeller. But making power turn corners and all the while changing the angles of those corners is no mean challenge.

To picture how the power is bent around corners, start with an input shaft coming off the flywheel in a more or less horizontal plane. Turn that power 90°, and feed it into a vertical drive shaft. In the lower unit turn it another 90°, and let it rotate the propeller shaft. At each stage, there are problems.

First, angles of tilt, trim, and steering must be handled by an angle-drive joint just before the power turns the first corner into the vertical shaft. Secondly, there are many subtle complications that sneak in as torque and temperature differences cause the necessarily light and streamlined housings to flex, expand, contract, and slightly misalign the precisely assembled network of gears, shafts, and bearings.

Add to these headaches the demands of clutching, forward and reverse rotation, gear reductions, lubrication, cooling-water pickup, and corrosion resistance. Then dump hot water and exhaust gases down through the middle and insist that the whole works run submerged without leaking water into itself or the boat, and it's not surprising that all engineers don't agree on how to do it.

One thing they do agree on is the importance of a carefully matched package—engine, drive, gear ratios, propeller, and boat. That's why a stern drive is not something that you buy off the shelf and throw on your boat transom like a small outboard. The internal gear ratios must be

Continued

Buyer's guide to 1977 stern drives

Make	Model	No. cyl.	Hp @ rpm	Displ. (cu. in.)	Carb. or injection	Gear ratio	Reverse rotation	F'water cooling	Max. prop. diameter	Features
CHRYSLER	195	V8	195 @ 4200	318	2 bbl.	1.5 or 1.75:1	Yes	Opt.	16"	Economy model
	240	V8	240 @ 4600	318	4 bbl.	1.5:1	Yes	Opt.	16"	Electronic ign.
	265	V8	265 @ 4600	360	4 bbl.	1.5:1	Yes	Opt.	16"	Oil cooler std.
	105	6	105 @ 4000	198	Bosch In.	2.0:1	Yes	Opt.	16"	Diesel
	130	6	130 @ 3150	331	Bosch In.	1.5:1	Yes	Opt.	16"	Diesel
MERCRUISER	120	4	120 @ 4300	153	2 bbl.	1.98:1	No	Opt.	16"	
	140	4	140 @ 4600	181	2 bbl.	1.98:1	No	Opt.	16"	
	165	6	165 @ 4300	250	2 bbl.	1.65:1	No	Opt.	16"	
	470	4	170 @ 4200	224	2 bbl.	1.84 or 1.65:1	No	Std.	16"	Aluminum block
	888	V8	188 @ 4200	302	2 bbl.	1.5:1	No	Opt.	16"	
	898	V8	198 @ 4200	305	2 bbl.	1.5:1	No	Opt.	16"	
	228	V8	228 @ 4600	305	4 bbl.	1.5:1	No	Opt.	16"	
	228TR	V8	228 @ 4200	305	4 bbl.	2.0:1	Yes	Opt.	20"	Electric shift
	233	V8	233 @ 4200	351	2 bbl.	1.32:1	No	Opt.	16"	
	250	V8	250 @ 4600	350	4 bbl.	1.32:1	No	Opt.	16"	
	330TRS	V8	330 @ 4600	454	4 bbl.	1.5:1	No	Opt.	16"	High performance
OUTBOARD MARINE	120	4	120 @ 4400	153	2 bbl.	1.92:1	No	No	14"	
	140	4	140 @ 4400	181	2 bbl.	1.6:1	No	No	14"	
	175	V8	175 @ 4200	302	2 bbl.	1.39:1	No	No	14"	
	190	V8	190 @ 4200	302	2 bbl.	1.39:1	No	No	14"	
	235	V8	235 @ 4200	351	4 bbl.	1.16:1	No	No	14"	
VOLVO	AQ130D	4	108 @ 5500	121	1 bbl.	2.15:1	Yes	Opt.	16"	
	AQ140A	4	123 @ 5500	130	1 bbl.	2.15:1	Yes	Opt.	16"	
	AQ170C	6	158 @ 5000	182	1 bbl.	1.89:1	Yes	Opt.	16"	
	AQ190A	V8	179 @ 4200	302	2 bbl.	1.61:1	Yes	Opt.	16"	
	AQ200C	V8	194 @ 4400	305	2 bbl.	1.61:1	Yes	Opt.	16"	
	AQ225C	V8	211 @ 4400	305	4 bbl.	1.61:1	Yes	Opt.	16"	
	AQ240A	V8	227 @ 4200	351	4 bbl.	1.61:1	Yes	Opt.	16"	
	AQ225A	V8	251 @ 4400	350	4 bbl.	1.61:1	Yes	Opt.	16"	
	AQD21A	4	62 @ 4500	129	Bosch In.	2.15:1	Yes	Opt.	16"	Diesel
	AQD32A	6	90 @ 4000	193	Bosch In.	2.15:1	Yes	Opt.	16"	Diesel
	AQD70C	6	265 @ 2500	410	Bosch In.	1.89:1	Yes	Opt.	24"	Diesel
	AQD70CL	6	265 @ 2500	410	Bosch In.	1.89:1	Yes	Opt.	24"	Diesel, layover mfg.
	AQD401	6	130 @ 3600	210	Bosch In.	1.61:1	Yes	Opt.	16"	Diesel, new model

Comparing the stern drives

Make	Model	Mount	Type of flex drive	Gear-red. location	Clutch type	Clutch location	Tilt means	Trim means	Reverse rotation	Tilt degree	Steer degree	Fresh-water cooling
MERCRUISER	120	Transom	Univ. joint	Upper unit	Dog	Lower unit	Hyd.	Hyd.	No	53°	60°	Optional
	140	Transom	Univ. joint	Upper unit	Dog	Lower unit	Hyd.	Hyd.	No	53°	60°	Optional
	165	Transom	Univ. joint	Upper unit	Dog	Lower unit	Hyd.	Hyd.	No	53°	60°	Optional
	470	Transom	Univ. joint	Upper unit	Dog	Lower unit	Hyd.	Hyd.	No	53°	60°	Standard
	888	Transom	Univ. joint	Upper unit	Dog	Lower unit	Hyd.	Hyd.	No	53°	60°	Optional
	898	Transom	Univ. joint	Upper unit	Dog	Lower unit	Hyd.	Hyd.	No	53°	60°	Optional
	228	Transom	Univ. joint	Upper unit	Dog	Lower unit	Hyd.	Hyd.	No	53°	60°	Optional
	228TR	Transom	Univ. joint	In boat	Mult. dsk.	In boat	Hyd.	Hyd.	Yes	53°	60°	Optional
	233	Transom	Univ. joint	Upper unit	Dog	Lower unit	Hyd.	Hyd.	No	53°	60°	Optional
	250	Transom	Univ. joint	Upper unit	Dog	Lower unit	Hyd.	Hyd.	No	53°	60°	Optional
	330TRS	Transom	Univ. joint	In boat	Mult. dsk.	In boat	Hyd.	Hyd.	Yes	53°	60°	Optional
CHRYSLER	300	Transom	Univ. joint	Upper unit	Cone	Input shaft	Hyd.	Hyd.	Yes	52°	60°	Optional
OUTBOARD MARINE	Stern Drive	Boat stringers	Ball joint	Upper unit	Spring magnet	Lower unit	Elect.	Elect.	No	75°	90°	No
VOLVO	280	Transom	Univ. joint	Lower unit	Cone	Vert. shaft	Elect.	Manual	Yes	60°	60°	Optional

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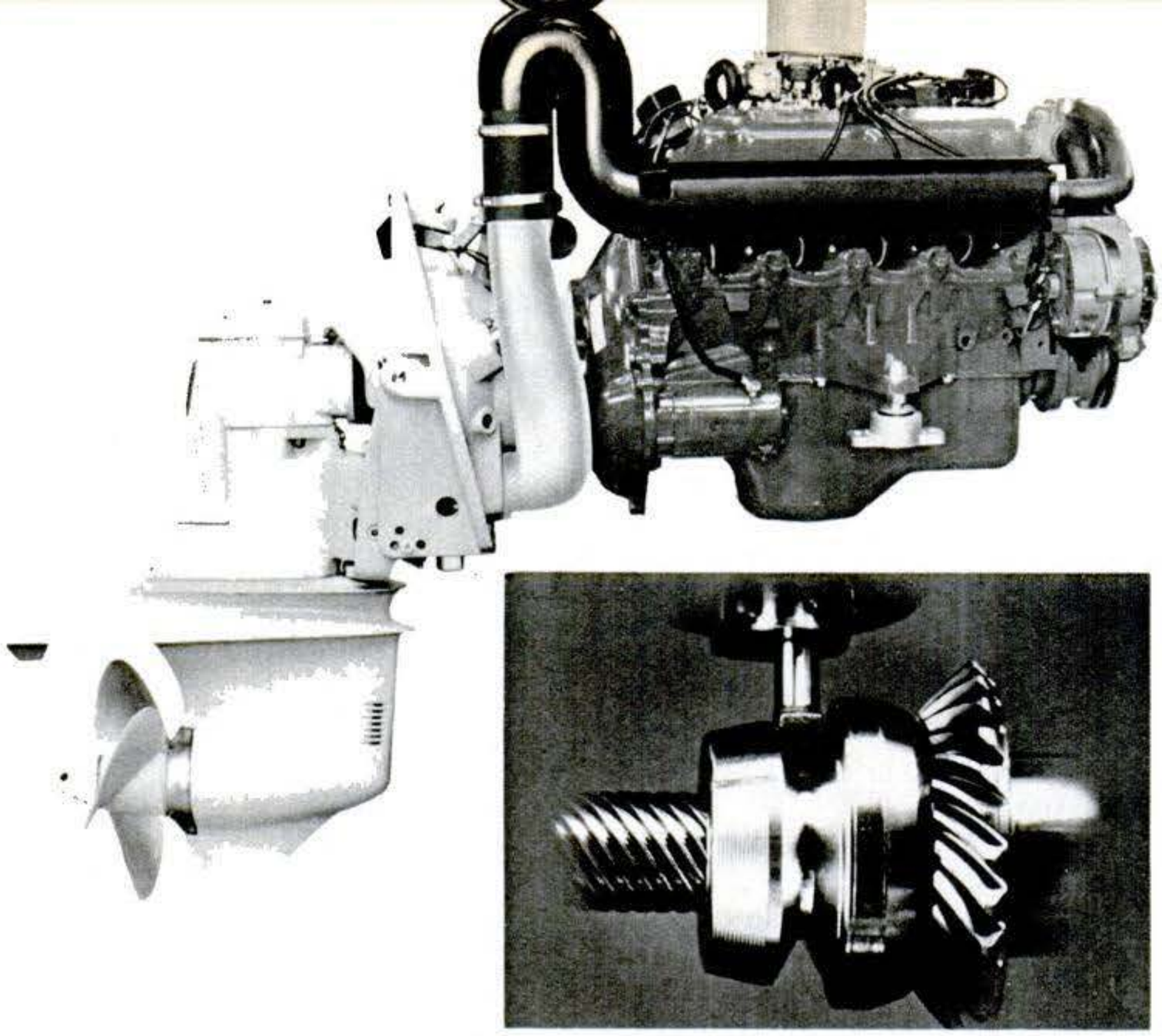

Volvo Penta AQ 190/280 has a spiral cone clutch (inset) to aid engagement of gears. The lower unit has a small centrifugal oil pump on prop shaft to lubricate the gears. Volvo I/O, like Chrysler, also offers right- or left-hand rotation.

matched to both the engine-performance characteristics and the type of boat.

Externally, most stern drives look much alike. Internally there are these big differences:

- Mounting and coupling to engine.
- Flex-drive type.
- Clutch location and type.
- Trim, steer, and tilt angles.
- Reverse-rotation ability.
- Lubrication.

Chrysler, MerCruiser, and Volvo all mount and support the drive on the transom. Basically, a support ring or mount face snugs up to the transom surface to provide a fixed and permanent alignment and seal. Vibration-isolating engine mounts support the engine, and a universal joint connects engine and drive. All tilt and trim movements are handled by the tilt range of the stern drive itself.

Outboard Marine mounts the stern drive to the rear engine housing and passes the drive housing through a flexible, diaphragm-like seal in the transom. Tilt and steer are done with the stern drive, like the others, but trim is produced by raising or lowering the front of the engine either hydraulically or electrically by a special jack-like front mount. This way you're always able to come back to the same trim angle after tilting, which OMC considers an advantage.

Again, Chrysler, MerCruiser, and Volvo are alike in using conventional U-joints in the input shaft to permit tilting and trimming. These joints resemble those used in your car's driveline. OMC says that U-joints limit tilt travel and steering range, so it uses a novel ball-joint drive consisting of stubby, hardened, stainless-steel fingers or balls interlocking somewhat like ancient peg gears. Their steering range is a full 90° (45° each way) compared with the 60° range of the others. And they can, indeed, tilt the drive up 75° rather than the approximately 52° of Merc and Chrysler, or the 60° of Volvo. None of these rigs, however, is really recommended for more than limited, low-power running in higher tilt positions.

Clutches

For sheer simplicity, MerCruiser's outboard-type dog clutches probably can't be beat. A single, double-face dog is splined to the prop shaft and slides forward or backward to engage forward or reverse gear. How much "clunk" you get when the dog locks in depends on engine speed, but at normal idle it's no big problem.

OMC's electrical and spring-wrap clutch is smoother but more complex. Instead of a mechanical link, a double electrical lead to the clutch in the lower unit energizes either a forward or reverse magnetic coil, snugs it up against the gear hub, and causes a spring-like coil to wrap around the shaft and grip it tightly to lock gear and hub together. The opposite gear runs freely.

In contrast, both Volvo and Chrysler have their clutches in the upper rather than the lower end. And both use cone clutches to hitch the proper gear to the driveshaft. Volvo's, however, is located on the vertical shaft, and the sliding clutch member rides on spiral grooves so that when the shift fork brings one or the other tapered cone face into contact with its mating surface in the gear hub, a "wringing" self-energizing action aids engagement.

Chrysler, wanting to keep rear and vertical projection low, uses a cone clutch mounted on the horizontal, power-input shaft. Instead of the spiral Volvo uses to aid engagement, Chrysler builds some little ramps of the gear/clutch cone interface that synchronize the speed of the gear train to the engine speed, then force engagement pressure to increase with engine torque. Both gears are constantly meshed with the drive-shaft gear. One is driving, and the other is turning free—but in reverse. So one penalty of the shaft's horizontal position is that the free-running gear is turning twice engine speed relative to the shaft. Chrysler uses needle bearings to compensate for this.

Both Volvo and Chrysler offer right- or left-hand rotation. On Volvo you must take the cover off the upper unit to change rotation. On Chrysler you do it at the engine-control connection. OMC engineers say changing rotation is not important on a stern-drive boat since you have the full swinging action of the propeller for steering, in contrast with the torque problems of inboard twins and rudder steering only. In any case, OMC's stern drive cannot be converted to opposite rotation. The same is true of Merc except for its heavy-duty drives, which have a planetary gear and hydraulic multiple-disk clutch inside the hull.

Tilt/trim

Tilting and trimming reveal more different viewpoints. OMC tilts with an electrical/worm-gear drive; others use electrically driven hydraulic pumps and hydraulic cylinders. All, of course, have provisions to take impact and kick up if you ram an obstacle. Chrysler and Merc use the same hydraulic units for trim. Volvo doesn't offer any on-the-go trim, but does have three positions of trim you can set by repositioning a pin manually. Chrysler claims that its trim system lets you adjust to almost any transom angle.

The most striking differences in design viewpoints show up when you start asking about stern-drive lubrication, maintenance, and engine service. OMC is strictest about these things. None of them recommends that the owner attempt internal re-

[Continued on page 153]

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The other story about the controversial B-1

The fate of the B-1 is in question—but the technological breakthroughs it has already sparked will indelibly alter the future of flying

By JIM SCHEFTER

No later than June 30, or perhaps even before you read this, President Jimmy Carter will decide whether the B-1 program lives, dies, or hibernates. Opponents of the program—they call it the "B-1 Bummer"—cite noise problems, possible ozone-layer damage, and general high costs, and question whether a new bomber is needed at all. The arguments on both sides are emotional and heated.

But the B-1 arguments, pro or con, are not the issue here. Whether the B-1 lives or dies, say aviation experts connected with the plane's development, its contributions to military and civilian aircraft of the next two decades—in the comfort,

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safety, and economy of the jets you and I ride—will be remembered in aviation history.

To find out just what aviation advances the B-1 has generated, I went to southern California. I talked to designers and engineers at the Rockwell International plant in El Segundo; I went to Palmdale, where the B-1 is pieced together, and to Edwards Air Force Base, where it's being flown. I talked to pilots, to avionics experts, and to aerodynamicists. I poked around a B-1, had free access to its cockpit—and I saw the future.

Since 1970, when Rockwell won the B-1 contract [PS, Nov. 1970], more than $2.8 billion has been spent on the program.

Even if the project is shelved, our tax dollars have already bought important technological advances:

- An aerial shock-absorber system that takes the "twanging and bobbing" out of flight turbulence.
- A new external design that blends part of the wings with the fuselage to form a single structure.
- Avionics improvements that eliminate the need for standard flight instruments.
- Turbofan jet engines that may be the best subsonic power plants made —but still have the power to ram the B-1 to Mach 2.2.
- Maintenance innovations ranging from almost-instant engine replacement to a system that tells mechanics what component to fix.
- An electrical system so advanced (it eliminated 29,000 individual wires) that it almost didn't get into the airplane.
- Pioneering construction techniques, including diffusion bonding already adapted for the Space Shuttle, that reduce assembly-line time to near-record lows.

Although the B-1 is a military machine, each of these advances has civilian applications. Some can be modified and retrofitted to the jets we're riding today. Others will be designed into the next generation of aircraft.

Unlike the B-52 it may replace, the B-1 can make supersonic dashes at 50,000 feet. It's really two airplanes in one: a subsonic heavy transport that can fly 5000-plus miles from here to there without refueling, and an SST that streaks along at more than 1400 mph. The aviation advances I've mentioned brought the two craft together and made them one.

"This airplane's main mission is to penetrate defenses at low altitude," explained John Wykes, lead engineer for dynamics.

To B-1 crews, low altitude means 200 feet above the ground. Every heat ripple, every deflected wind gust, batters the airplane. For the people inside, it could be downright miserable.

But it isn't.

The solution was a pair of small vanes or winglets, mounted on the B-1 nose under the cockpit. When switched on, the hydraulically actuated vanes automatically twist and swivel in response to accelerometer signals. These are routed through an electronic controller. Rockwell calls the setup the Structural Mode Control System (SMCS).

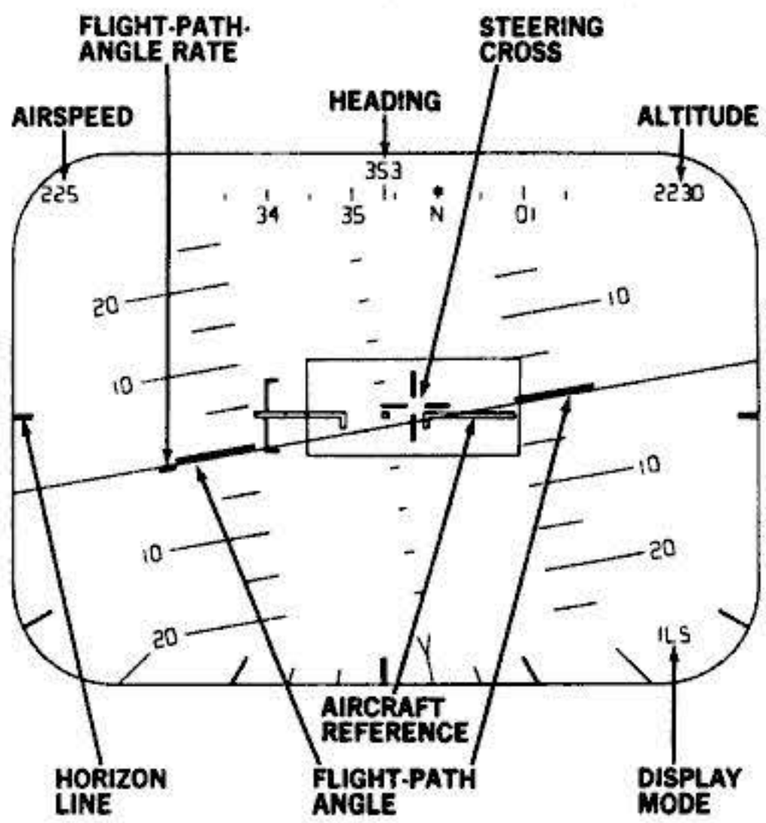
"Like the shock absorbers on your car," Wykes said, "the vanes damp out vibrations. When flying low, you've got turbulence in two directions, up and down, and side to side. The whole aircraft structure can start twanging and bobbing. The vanes swivel toward each other to absorb the bobbing, and work opposed to damp out the twanging."

Since they flip through an arc of plus or minus 20 degrees, at speeds up to 200 degrees per second, the vanes can be in and out of synchronization faster than the eye can follow. And they're not just for low altitudes —they work equally well up high, taking the sting out of clear-air turbulence or rough weather.

"The pilots had never seen anything like them before, and there was some antagonism," Wykes added. But, that soon disappeared.

Reported Rockwell chief test pilot Charlie Bock, at the controls on an early flight: "The ride was very uncomfortable until the SMCS was turned on."

With the aerial shock absorbers drawing rave reviews, the Air Force told Rockwell to patent the system.



One miniature TV screen does the job of many navigation instruments. It can also show pilots a detailed picture of the ground below, even in low visibility.

It's available now to any other big plane builder.

"It's better to design it into the aircraft from the start, but a system like this could be retrofit onto commercial jets today," Wykes said. "All you'd need is to add vanes in the back to spread the effects through the passenger compartment."

No more flying cigars?

Another B-1 innovation: the "blended wing body." Most big jets look like cigars. But the B-1's body flares out in a smooth curve, then sweeps back. The curves flow from top to bottom and from front to back. Much of the wing is actually fuselage. Only the part that moves—the B-1 is a swing-wing craft—is separate.

"Integrating the wings with the fuselage gave us some real advantages," Len Rose, assistant director for B-1 research and engineering, told me. "The old way was to save weight by making a wing thicker. But with the blended wing, we got a thin wing, lighter weight, and a longer chord [distance between leading and trailing edges of the wing]." They also got extra volume in a smaller body, volume used for fuel avionics and other equipment; structural weight reduction of more than five percent; no increase in subsonic or supersonic drag; and a decrease in transonic drag. Rose thinks the added volume, increased flight efficiency, and easier manufacturing of a blended-wing body should make the design attractive for commercial transports. "But," he noted, "there's one potential trouble spot for passenger designs: It's hard to see out over the blended wing."

Visibility is no problem for the B-1 flight crew. Sitting in the commander's position is like being inside an aquarium. The windshields are mammoth; there are overhead windows to give a view straight up (useful during refueling); and the nose drops away so steeply that all you see out front is air. But the avionics in the instrument panel, not the airy feeling, are the most visible innovations. First, you notice what's missing from the central control panel: air-speed indicator; gyro horizon and compass; radio navigation instruments; and the instrument landing system (ILS), glide slope, and marker beacons that are key to landing in poor visibility.

What's left? Just an eight-inch TV screen that takes over for all those instruments, does their job better, and has capacity left over for other in-flight assignments. It's called VSD, for Vertical Situation Display.

Nobody knows that little screen bet-

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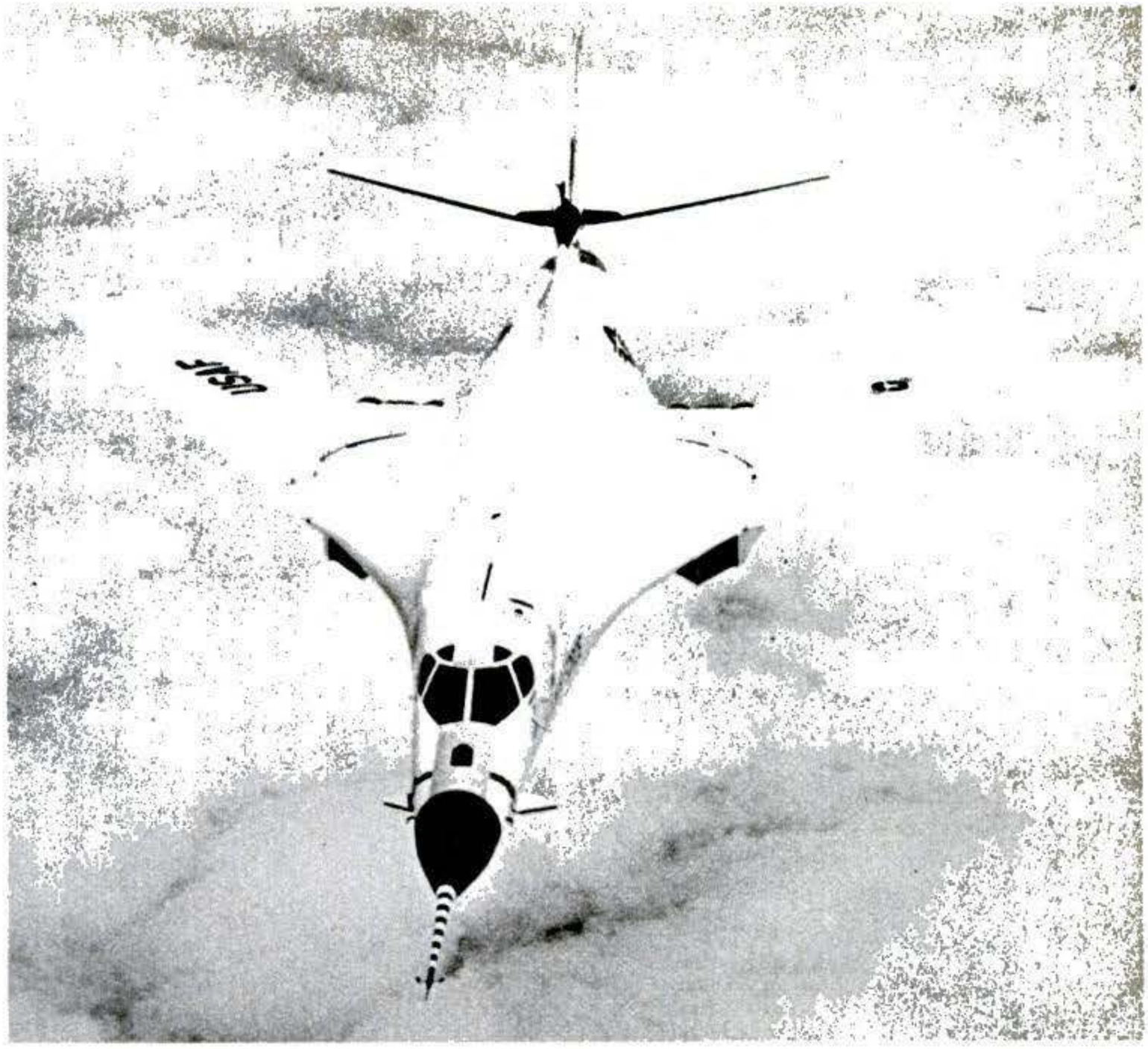

B-1 controls are studied by author (above). To the right of advanced VSD screen is backup set of standard navigation instruments. At far right, innovative "PWR LEVEL" display houses computer-driven tape that shows engine thrust. Photo at right shows curves of B-1's blended-wing body, which cut weight.

ter than Charlie Bock. A slim, graying, soft-talking aviator, Bock's position as chief test pilot has given him more flying hours (200-plus) in the B-1 than anyone. He's logged most of them while watching that tube.

"The VSD literally has an infinite data capability," he said. "We have to guard against putting too much on there and cluttering it up."

In a typical in-flight configuration, the screen is bisected by a line representing the horizon (see diagram). There's a steering cross that is the aiming point, and a pair of horizontal "wings" that are the airplane. Just touch the stick (that's right, the B-1 has a stick instead of a steering yoke) to keep the little wings centered on the steering cross, and you're on course.

The electronics behind that simple explanation is considerably more complicated. The steering cross gets its orders from the flight-director computer, which may be receiving constant input from ground-based navigation radios, or from the on-board inertial system, or from radar transponders, or altimeters—or any combination of these. For instance, in one mode, the steering cross gets radar inputs on the location of a refueling tanker. By flying the wings toward the cross, the B-1 pulls right up to the tanker, even in low visibility.

In other modes, everything the pilot needs to fly an instrument approach is on the screen. The glide slope is a rectangular box; keep the wings in the box, and you're home free.

That's not all.

All the standard information—altitude, airspeed heading, angle of attack, and more—can appear on the screen in digital format. Then come other options—such as a flight-path-angle bar that sits on the horizon when the aircraft is level, and a TV-like view of the world outside.

Electrons don't get tired

All of it can be hooked up to the computerized autopilot, programmed in advance, and flown virtually hands-off. The pilot is needed only for takeoff and the last 100 feet before landing.

"We can set in a route from here to Reno to Salt Lake to Fort Worth and back and do it all automatically at 200 feet off the ground," Bock told me. "Over the long run, the auto-system performs better than the pilot. I get tired, and the electrons don't."

(As good at it is, the VSD still has an aura of black magic about it, and nobody—not even Charlie Bock—trusts it completely. So six inches to the right is a little cluster of familiar dials: altimeter, gyro horizon, and rate of climb. Bock doesn't use them, he says, but "it's nice to know they're there—just in case.")

Two more instrument innovations may become commercial aviation standards.

"We use standard computer-driven vertical tapes for all engine instruments," said flight test engineer Dick Abrams. He pointed to one of them—a rectangular case displaying a calibrated tape.

"That's something the FAA has been pushing for," he revealed. "It shows the percent of power being developed in each engine. For all intents and purposes, you're reading thrust. When you know that, you have the most important fact about your engines."

The second instrument is a center-of-gravity control and readout. "Just select the center of gravity you want, and the system automatically pumps fuel around the airplane to keep you there," Abrams said. He explained that fuel lines connect fuel tanks in the wings, fuselage, and tail, so fuel can serve double duty as a stabilizing agent.

That system has commercial implications. By keeping the aircraft in the most efficient flight attitude, it makes flying a little easier for crews, a little more comfortable for passengers, and a little more economical for airlines.

Now we come to that TV image of the outside world that can be called up on the VSD screen. It's the output from a Forward-Looking Infrared (FLIR) system built by Hughes Aircraft Co. The FLIR reads heat emissions and displays them as a reverse TV picture. When the pilot calls up the FLIR image on his VSD screen, with flight data superimposed, he has a uniquely complete picture of what is happening.

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Radical new avionics improve flight safety and cut maintenance time

"Nighttime sensitivity on FLIR is as good as daylight sensitivity for the human eye," said Charlotte Zelon, lead engineer in the defense avionics group.

Bock and other pilots have used FLIR to help them taxi the B-1 in low visibility, to watch their refueling tanker, and even to assist in making an instrument approach.

"For a general aviation system, you could build this a quarter the size and at a fraction the cost," Zelon said. "It's an aid to low-level night flying and landing. That's good for anybody who flies."

Just how good is FLIR? That's classified, Zelon said. But she did show me one dramatic application: "It's excellent for detecting fires, even at very long ranges," she noted, pulling out a set of Polaroid prints made from a FLIR unit on the roof of Hughes Aircraft's Culver City plant. The first, a conventional photo, showed gray haze, a nice view of nothing. The rest were startling.

"That's the 1974 Topanga Canyon fire," Zelon said. "You're looking right through heavy smoke 15 miles away."

The fire, invisible without FLIR, was clearly outlined. Ridge lines and other terrain features showed up. Hot spots glowed brightly. What's a little ground fog during landing when FLIR can cut through smoke like that?

An ecologist's dream engine

Environmentalists won't have to worry about smoke from the B-1 engines. Developed by General Electric, the F101 turbofan is clean, quiet, and efficient. It's smokeless. It already meets every known pollution standard for aircraft *and* automobiles.

Most of the engine data is classified. Those who know speak only in generalities. Thrust? In the 30,000-pound range. Fuel consumption? No specific numbers, but at subsonic speeds, it's 99.5 percent fuel efficient and when flying subsonically it uses 25 percent less fuel than B-52's. How did they get such an engine? The details are secret.

"But the B-1 engine core [which is not classified] could be the new power plant for the next generation of medium-haul transports," Tom Stafford, commander of the Flight Test Center at Edwards AFB, told me.

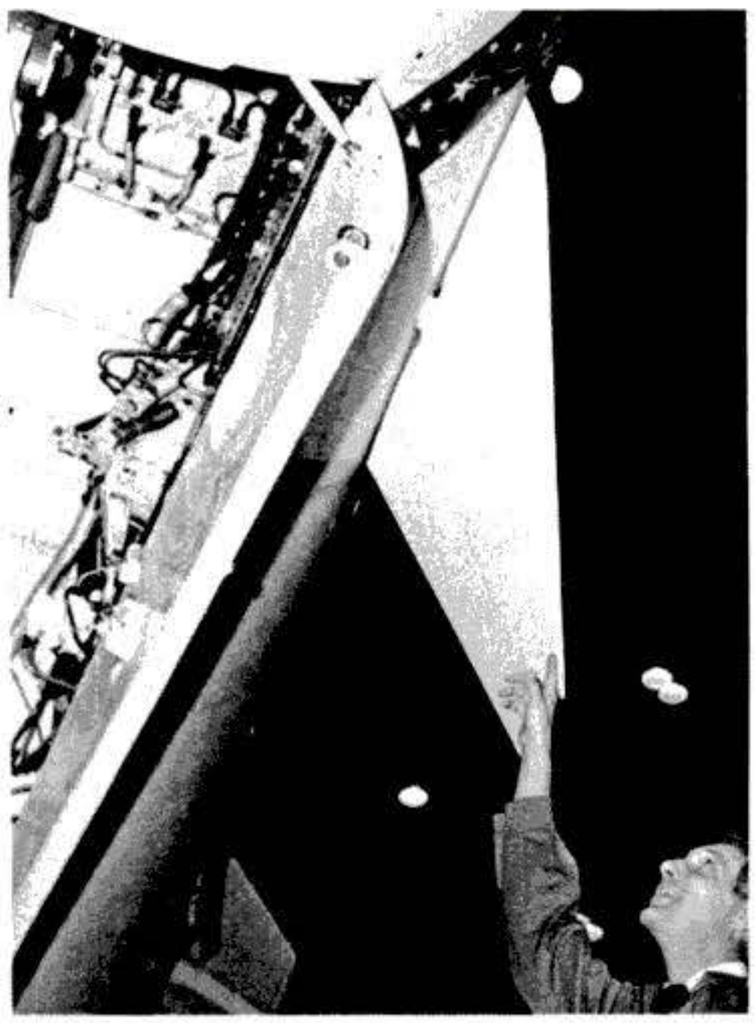
The engines are designed for easy starting and easy maintenance. In one test, an Air Force maintenance crew pulled a dummy engine and replaced it with a new one in just 22 minutes. And the engines aren't the B-1's only maintenance advance.

A built-in Central Integrated Test System (CITS) is yet another system that big-plane designers are certain to want for future transports.

CITS has a threefold function: It gives the crew immediate warnings on degraded performance; printouts on actual performance; and repair instructions to ground crews.

"Airlines today record information in flight and rely on ground processing to isolate trouble," said engineer Pete Kubischta. "They're going to have to go to in-flight processing."

That's what CITS does. It electronically scans every important B-1 subsystem several times each second, bringing in more than 3000 separate signals (but using just 800 wire pairs) to detect and isolate performance problems. By selecting additional readings, up to 9000 individual parameters can be monitored. A small display unit lights up to identify which system—engine-fuel, electrical, or other—is out of tolerance. Then an alphanumeric display gets more specific: "low air pressure," "unit hot," or whatever is wrong. And, it can be instructed to give a continuous readout of the actual figures (air pressure, temperature, etc.), thus showing exactly how serious the problem is.



B-1's shock absorbers are tiny wings that work with matching ones on the other side to damp out in-flight turbulence. Here, test pilot Charlie Bock points to one.

For instance, in one test flight, payload-bay temperatures jumped. That usually requires an immediate landing. Instead, the crew members used CITS to watch the temperatures while they shifted to a manual cooling mode. The temperatures dropped, and the flight continued another four hours.

Computer-assigned repairs

"CITS gives the flight crew about 200 times more information than a DC-10 crew gets," said Herb McCoy, lead engineer on the system. "It's good for flight safety and also for maintenance. The ground crew uses it as much as the flight crew."

The difference between CITS and an old-fashioned monitoring or maintenance system is the difference between raw data and actual information, McCoy pointed out.

"The gas gauge on your car doesn't tell you how far you can drive," he said. "So that's just data. With CITS, we get information: 'Change box number so-and-so.' The mechanic doesn't care what went wrong. All he needs is the information on what to do—and that's what CITS provides."

To keep permanent records, the system notes failures and summarizes all data from other systems on magnetic tape. It also prints out failure data—for use by mechanics—on paper tape.

CITS is fully controlled by a small on-board computer. Rockwell designers are looking ahead to next-generation improvements with even smaller units using microprocessors. Yet, the present version already is ahead of anything now flying. Through CITS, data recorded during flights or ground tests can be sent—directly or by telephone lines—to even bigger ground computers for extensive checkouts.

"You could fly that airplane into a wheat field and still run the full set of tests," McCoy said. "If you can reach a phone, you can feed all the data back to home base."

For commercial airlines, such a capability could significantly increase flying time by eliminating unscheduled runs to a maintenance base, or long hours of trial-and-error debugging at poorly equipped airports.

But even CITS needs help. It gets it from that new electrical system that's known as EMUX, for electrical multiplexing—using solid-state electronics and time-sharing techniques to run multiple instruments and systems over a single pair of wires.

How does it work? To oversimplify, an instrument or system gets a fresh input from EMUX every 30 to 40 milliseconds. The rest of the time it's technically on, but idling. And during that miniscule idling time, EMUX is feeding power to other devices on the same circuit.

It happens so fast—30 times a

[Continued on page 162]

Balloon relay
for Iranian TV program

Blimp's crew prepares it for launching (above). At rest (below), the aircraft is protected from wind damage by boom, which swings on a circular track to keep it always headed into the wind.

A blimp hovers incongruously over the lonely Iranian desert. Its job? To transmit TV signals to the homes —and tents—scattered across the sparsely populated province of Baluchestan.

The giant balloon, operated by Pan American's Aerospace Services Division, under contract with Westinghouse, is launched daily. An electric winch pays out cables that tether the blimp to the winch tower and to the boom where the winch operator rides. The balloon ascends to altitude, where it picks up broadcasts sent from Teheran, some 900 miles to the northwest. The signals have come via telephone lines to a remote relay station, which beams them up to the balloon's repeaters. These are housed in the windscreen, a conical compartment joined to the balloon's underside. Three Wankel engines, each powering a 7½-kilowatt, 400-Hz aircraft generator, supply electricity to the transmitters.

While the balloon is aloft, the crew monitors all processes, using a remote-controlled RF link to make needed adjustments.

In its free time, the crew can tune in the balloon's broadcasts. The only problem: All programs are in Farsi. —*Richard H. Warren*

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Masonry floors

for easy-care beauty that doesn't wear out

Slate floor of foyer (above) will keep its handsome face through years of muddy boots and dripping umbrellas. Squares (Vermont Structural Slate Co.'s unfading gray) laid in straight lines complement contemporary setting. Right: Sophisticated patterns of terrazzo floor add elegance to a traditional dining room.

By V. ELAINE SMAY

Masonry floors—slate, marble, tile, terrazzo—traditionally have been found in those areas of the house that are exposed to extreme conditions: foyer, kitchen, bath, hearth. Their exceptional wearability makes them an excellent choice for such locations, but they needn't be confined there. Many are elegant enough for even formal settings. Wherever you put a masonry floor, you can be sure it will last—probably longer than anything else in your house. And throughout its indefinite lifespan, you'll spend almost no time or money to keep it looking its best.

Usually, the initial cost of a masonry floor is higher than that of nonpermanent flooring, such as carpet or resilient tile. But if you consider lifecycle costs, masonry floors are very economical indeed. A study commissioned by the American Tile Council found, for example, that carpeting was twice as costly as quarry tile was. Other masonry materials come more or less in the same range, depending upon initial cost.

Here's a rundown of the various types available.

Slate

This natural stone is quarried or mined, then sawed to the desired dimensions and hand-split to the proper thickness. (For home use, that's generally ¼- to ⅜-inch.) Hand-splitting along the natural cleavage of the stone gives slate its characteristic striated texture. It's also available with a smooth surface. Slate comes in a variety of shapes and subdued colors that can be mixed or matched.

Slate comes in two types: weathering, which will change its color to shades of brown when exposed to the elements; and unfading, which keeps its original color. In interior installations, however, even weathering slate won't change much.

If you're reasonably handy, you should be able to install a slate floor yourself. It can be put over a concrete slab or a reinforced wood floor. Some types of slate are designed to set in a cement mortar bed; others can be applied with adhesives. The thin slate appropriate for residential flooring can be cut with a hacksaw, so no exotic tools will have to be purchased or rented. When the floor is laid and set, you apply a grout between the stones. Slate for residential flooring probably will cost around $1 to $3 per square foot. Professional installation will probably cost an additional $2 to $3 per square foot.

Slate is a nonporous stone, not

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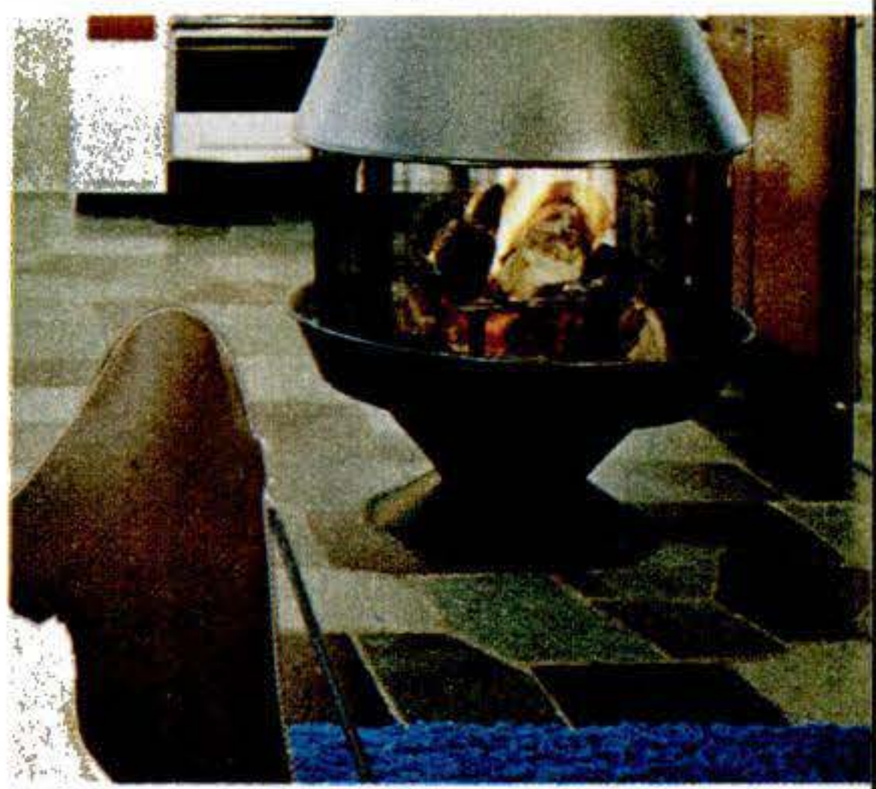
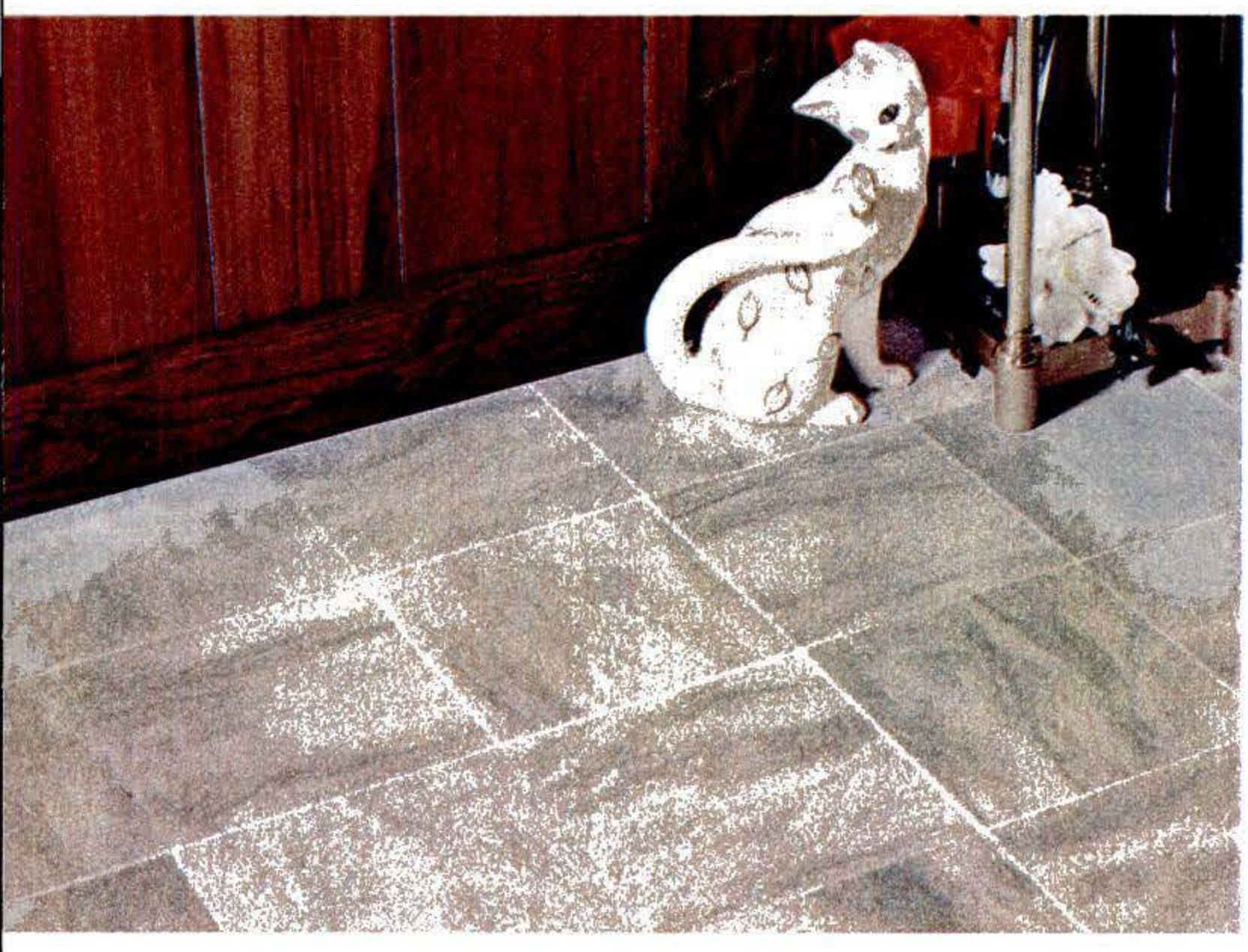
Quarry tile can be used indoors or out—as on this veranda. Four-by-eight-inch "Colonial Oak" tiles from Monarch make a real wash-and-wear floor.

Random slate flagging in full color range (green, gray, purple) is excellent choice for kitchen/dining area. Here it also provides hearth under fireplace.





Terrazzo floor stands up to roughhousing and spilled food and drink in finished basement recreation room. Colored divider strips add interest to the one-tone floor.

Elegant marble floor could spruce up any room in your house. This is from Vermont Marble Co.'s "Markwa" series (thin tiles made especially for home use).

prone to staining, but you may want to apply a sealer to protect the porous cement grout. A sealer will also enhance the colors of the slate. Water-soluble acrylic finishes are often used for this. Ask your dealer to recommend a specific product, or follow the advice of the slate producer. Waxing a slate floor is generally not recommended, but if you do wax, remove the accumulation every six months to prevent a buildup.

Ceramic tile

Ceramic tile is made of clays fired at high temperatures. It results in a very hard surface and nonfading colors. Ceramic tile comes in a number of types:

- Glazed tile: A liquid mix of metallic oxides and ceramic stains is sprayed on top of the clay tile before firing. The glass-like surface that this glaze forms after firing can be almost any color imaginable—solid or patterned—and the finish can be high gloss or matt, or something in-between.
- Mosaic tile: These are small, usually unglazed, tiles with the color integral throughout the tile. They come in one-by-one, one-by-two, and two-by-two-inch sizes and in a wide range of colors (usually subdued). To speed installation, the tiles come mounted on a backing in sheets that usually measure one-by-two feet.
- Quarry tile: This is heavy-duty tile, usually ½-inch thick, and very resistant to wear and abrasion. Traditionally the term has been reserved for unglazed tiles in warm earthy shades. Now, however, it is sometimes applied to any heavy-duty tile, even glazed tiles in bright colors. Quarry tile comes in a number of shapes, including hexagons, octagons, and complex shapes with interlocking dips and curves. (Pavers are similar to quarry tiles.)

Continued

Copyrighted material

With the proper adhesives, ceramic tile can be installed over just about any sound, nonflexible flooring, even over resilient tile. (Look for complete instructions on how to lay your own ceramic tile floor in a future issue of PS. Or send 25 cents to the Tile Council of America for their instructions.) Most tile outlets will rent you the necessary cutters and chippers. Consult the adhesive manufacturer if you want to install tile over floors with radiant heating.

Selecting the grout to go between the tiles can be almost as difficult as selecting the tile itself. You can use a traditional cement grout or a new epoxy, or a silicone-rubber formula. And the wide range of color in grouts broadens the design possibilities.

For a quick and easy DIY tile floor, you can use pregrouted sheets of tiles. With some, even the edges of the sheets are pregrouted, so you have only the perimeter of the room to grout after the tile sheets are laid.

Prices of ceramic tiles vary greatly —from about 70 cents a square foot up to $10. If you hire a contractor to install it, he'll probably charge from $1.50 to $4 per square foot.

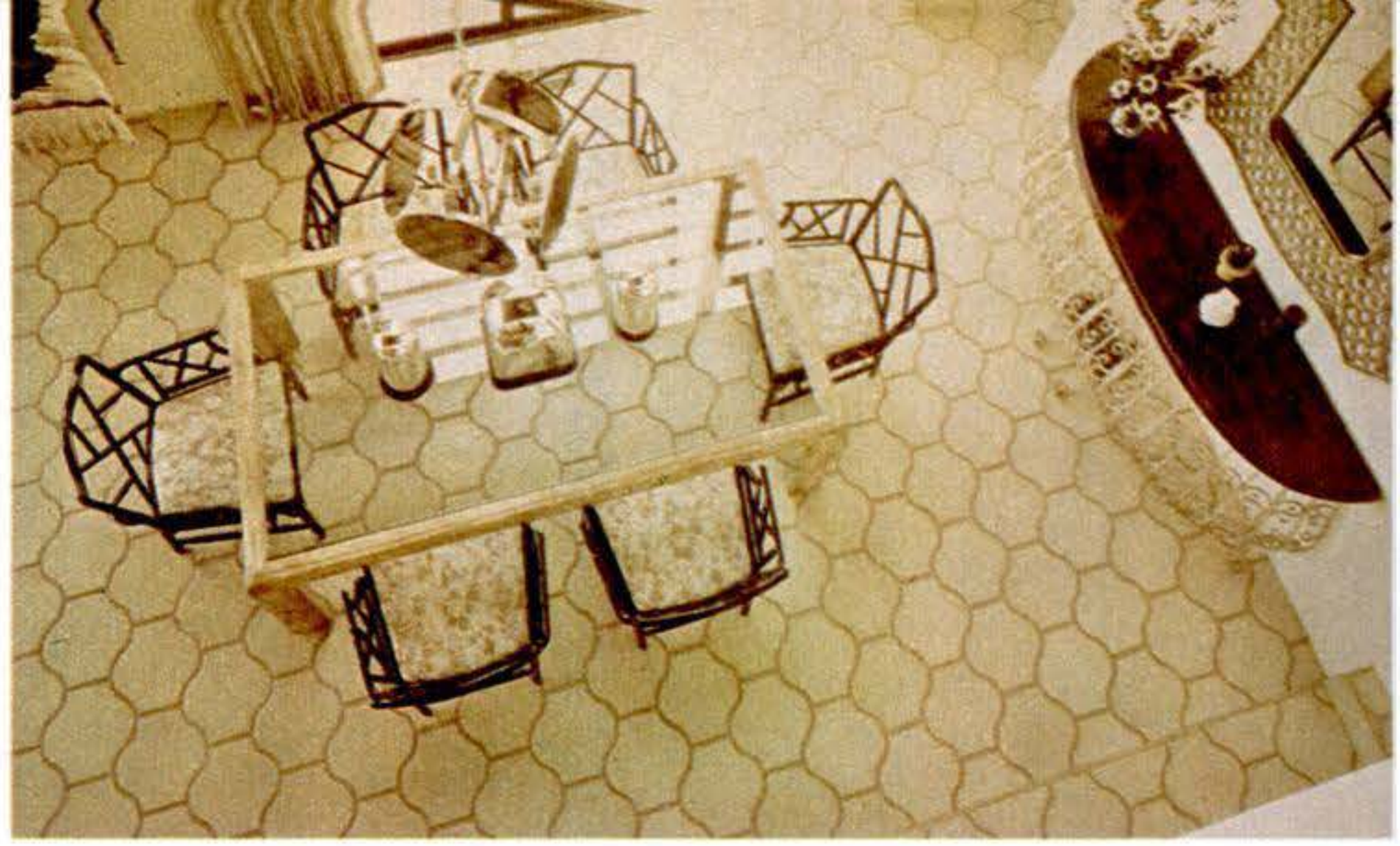
Some tiles need sealers, others do not, but you may want to apply one anyway to protect the porous grout from stains.

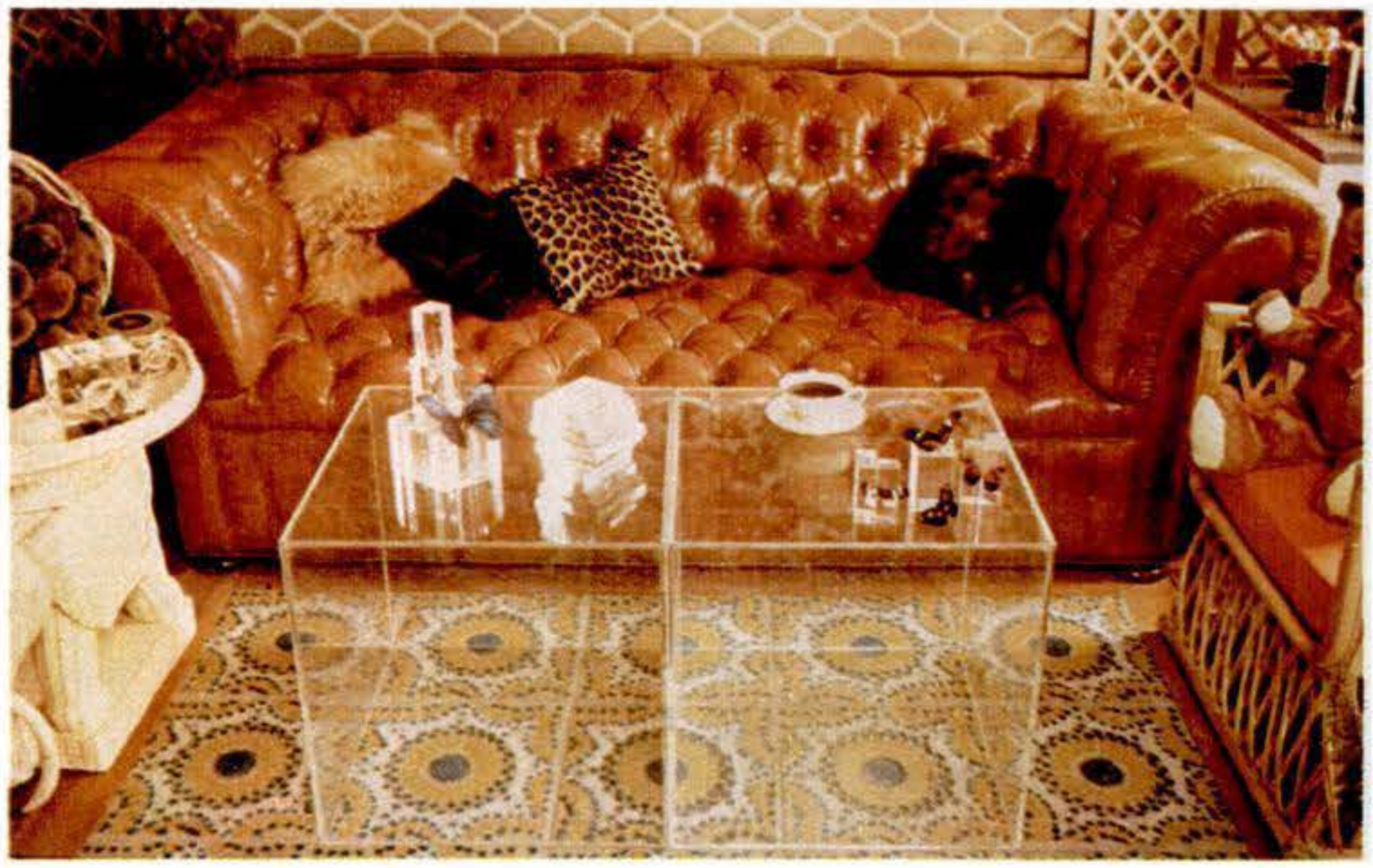
Marble

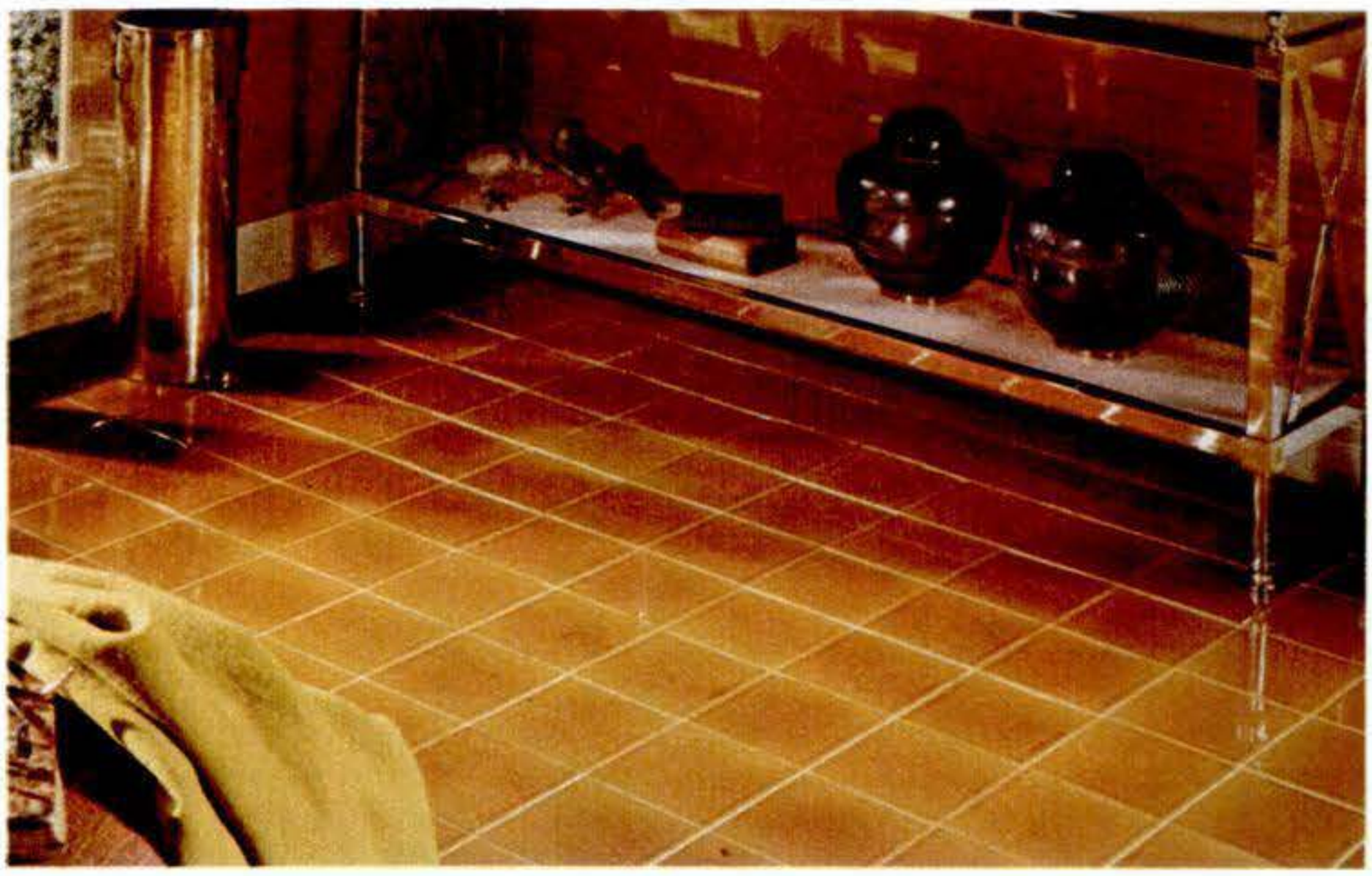
Marble is limestone that has been more or less crystallized by metamorphosis over the eons. Marble used for floors comes in satin and high-gloss finishes, and in a range of colors, usually with veins of other colors running through.

The word marble conjures up images of opulence, but a marble floor

[Continued on page 156]







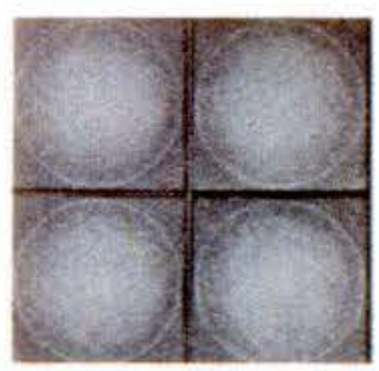
Pale ivory oversized floor tiles in complex shape (top) add design interest to an understated room. Middle: Brightly colored patterned tile makes eye-catching accent area—use as you would an area rug. Such bold patterns might be overpowering in large areas but are handsome when used judiciously. Right: Gleaming glazed tile (available in about any color) makes spectacular foyer floor. (Top and middle tiles are from American Olean; right is from Mid-State Tile.)

Imported glazed tiles

The floral and geometric tiles pictured across the bottom of these two pages are from Country Floors, Inc., 300 E. 61 St., N.Y., N.Y. 10021.

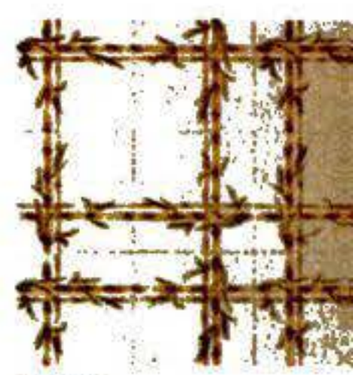
Palinuro

Orlandese



Universo black

Chevron



Bambu

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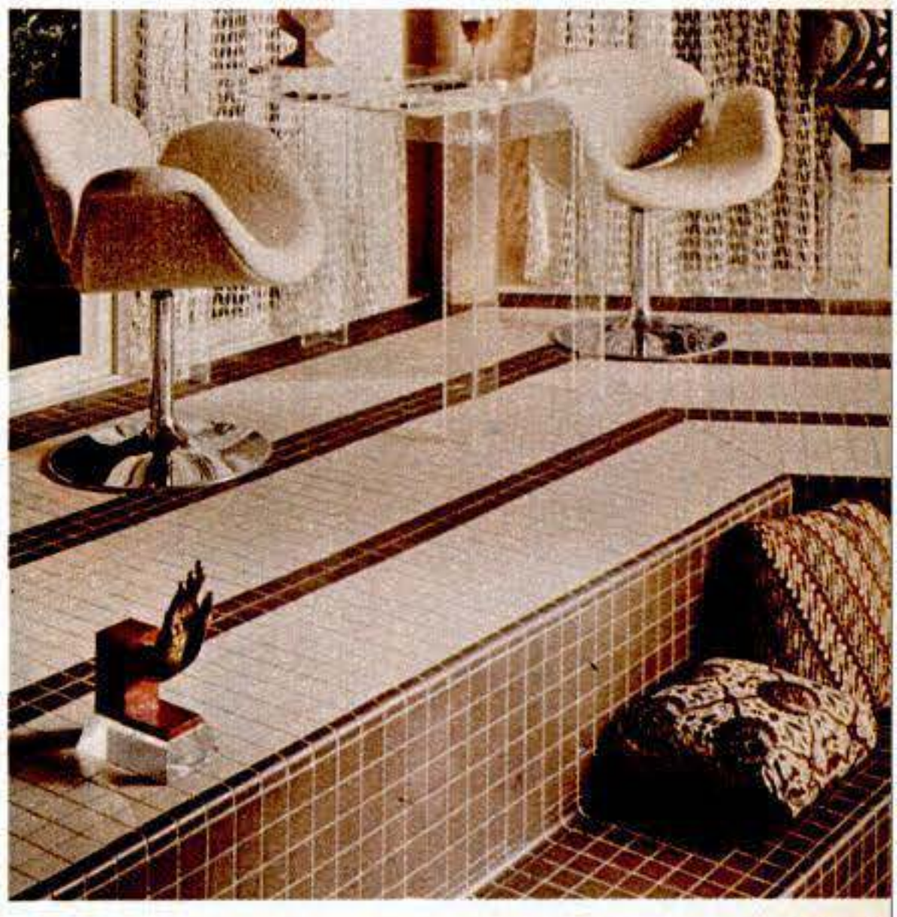
Unglazed mosaic tiles are laid in a pattern to enhance the Oriental feeling of this cabana. These are American Olean's 1-by-1 ceramic mosaics.

Light and dark bands of 2-by-2 mosaic tiles heighten geometry of multi-level room. Trim pieces let you turn interior and exterior curves. (American Olean.)



Basketweave installation of rectangular tiles adds interest. Other possibilities: straight lines, herringbone. (American Olean's Fawn Gray 4-by-8 quarry tiles.)

Mottled glazed tiles as on this kitchen floor come in a number of colors. These are eight-inch textured squares called "Briarwood," from American Olean.

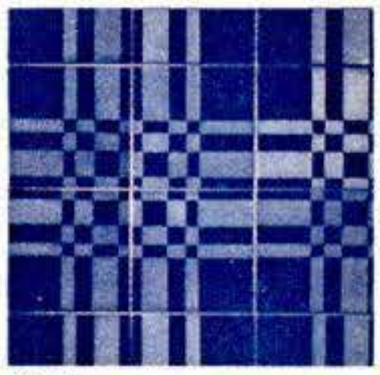
bi Fuji

Casablanca

Aragona

Listelli

Cerreto and Blancs



Astral

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Handsome, versatile sleep/play platform

With foam mattress in place, platform becomes a cozy bed—or a makeshift trampoline (above). Foam padding all around makes such bouncing a safe activity. With mattress removed (right), children have a gaily painted townscape with roads for toy-car pushing. (When your child grows older, you can repaint the panel to serve as a base for a favorite board game.) Side bins have plenty of room for toys and games, or you can store bedding in them.

Designed and built by Michael Simmons

This versatile platform bed is an easy, inexpensive project that makes an ideal first bed for a toddler—the foam-padded lids of the surrounding storage bins create a recessed sleeping area that he can't roll out of. Lift out the foam mattress and you uncover a colorful play surface. Those lift-off lids give quick access to spacious toy bins. The arrangement encourages neatness: Toys must be stored away at night before the mattress can be replaced. And the tough Naugahyde upholstery just wipes clean.

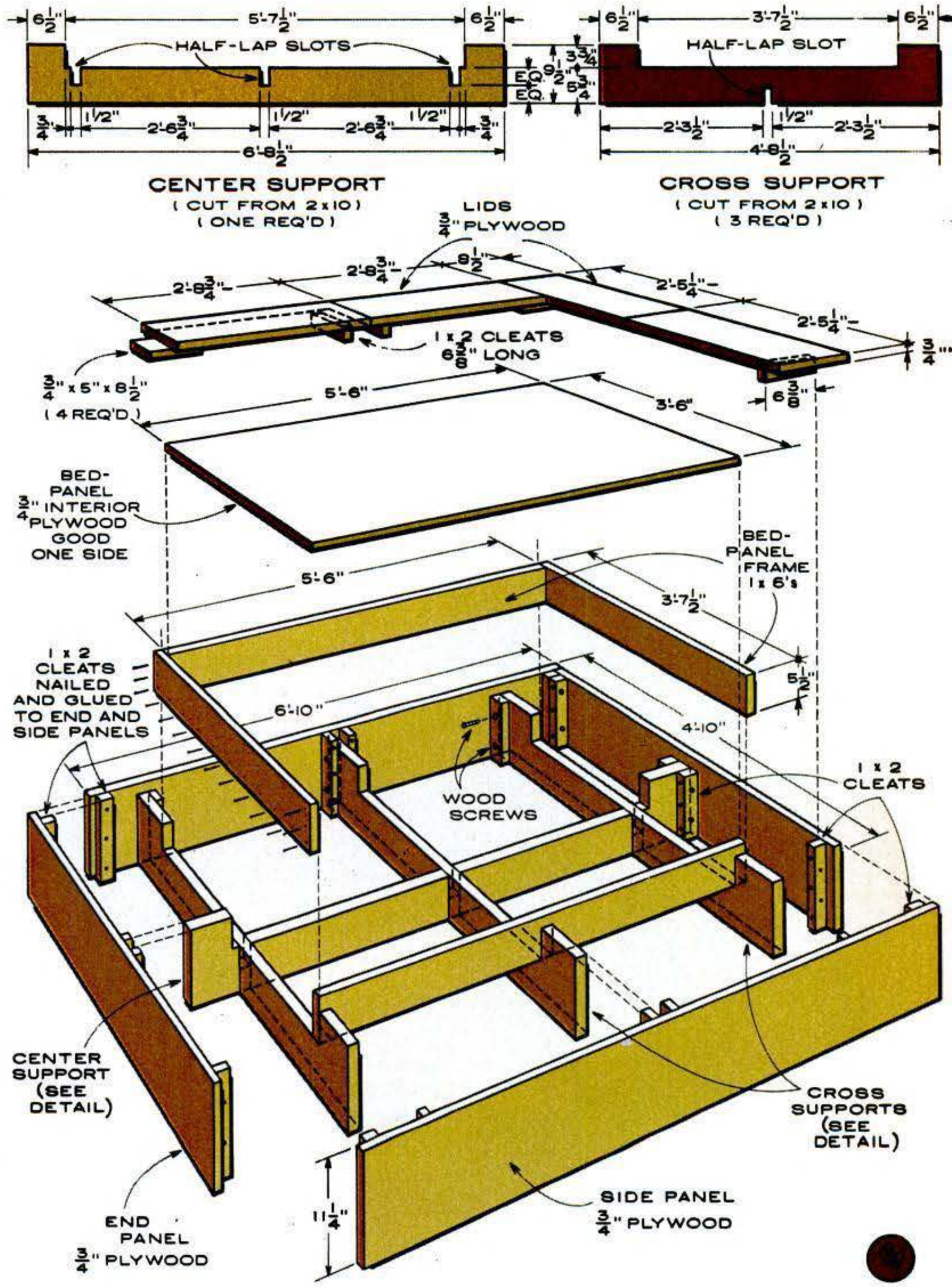
The bed also converts to adult size. Just drop on a two-inch-thick foam pad to match the outside dimensions of the structure, and you have a queen-size bed for two. PS

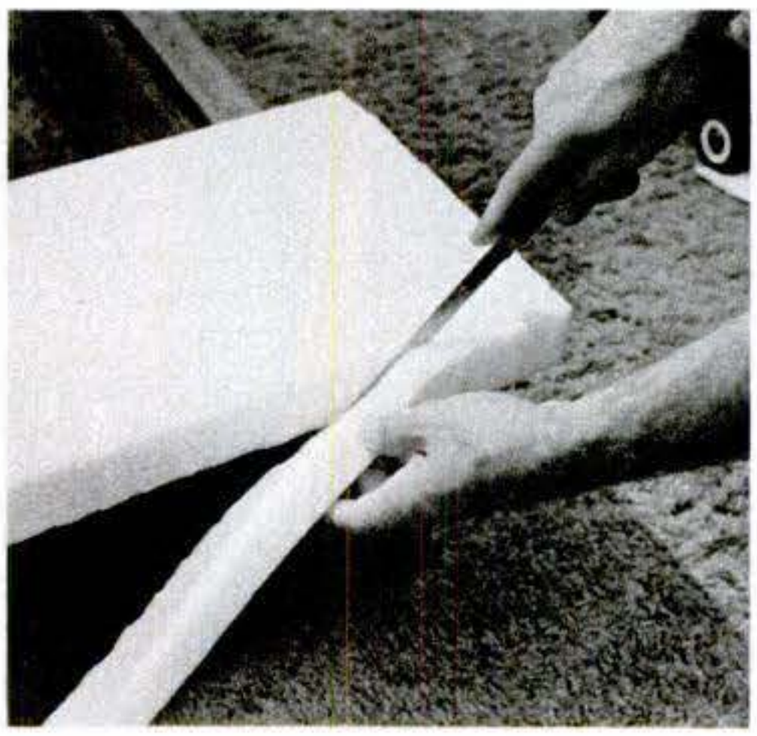
MATERIALS AND TOOLS USED

Naugahyde's "Spirit of '76," approx. $10 a yard, at upholstery outlets nationwide.

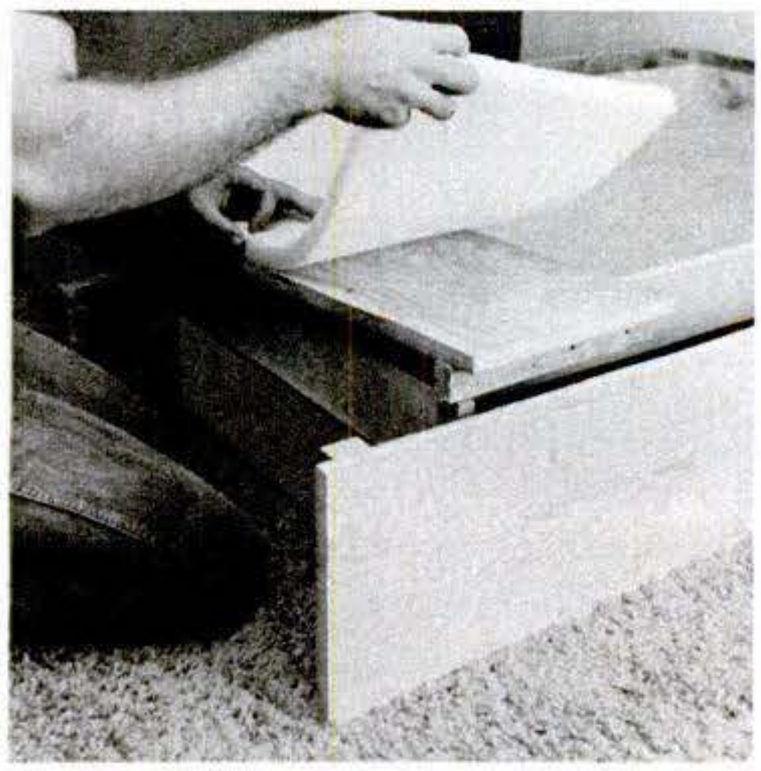
Duo-Fast Electric Staple Gun. Manufacturer's suggested list price, approx. $45.

All paint in room is Fuller-O'Brien.

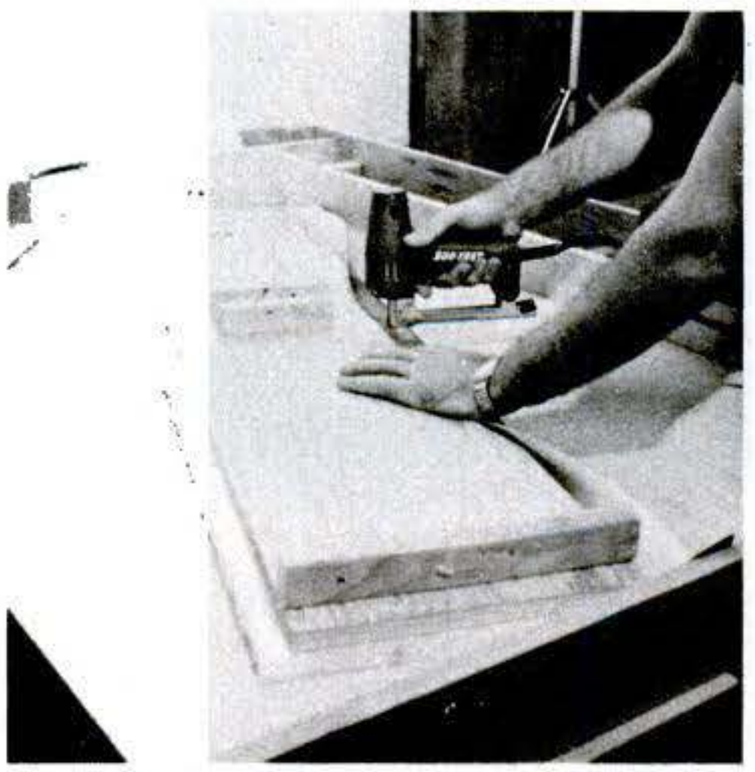




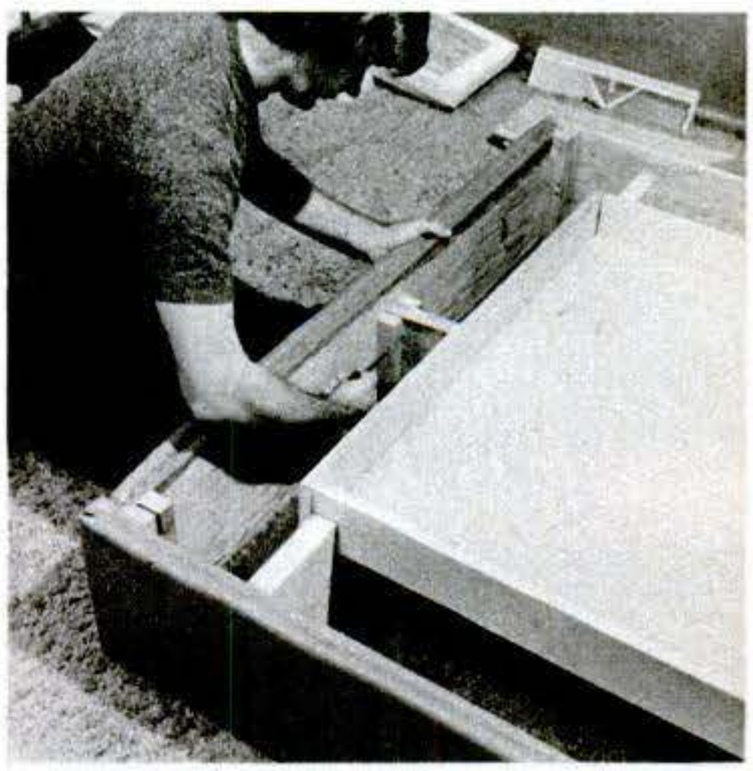
With serrated knife, cut foam padding to cover outer surfaces of platform bed. Foam should project beyond all exposed edges to provide protective "bumper."



Upholster sides of structure before assembly; Naugahyde cover will keep foam in place. Note dual cleat system that lets you connect panels from inside corners.



Stretch Naugahyde upholstery taut and staple to back face of panel. (Electric stapler like this Duo-Fast speeds job.) Use envelope fold to tuck in ends.



Egg-crate supports for sunken panel are screwed to cleats on frame. Method of assembly means outer structure can be taken apart without ruining upholstery.

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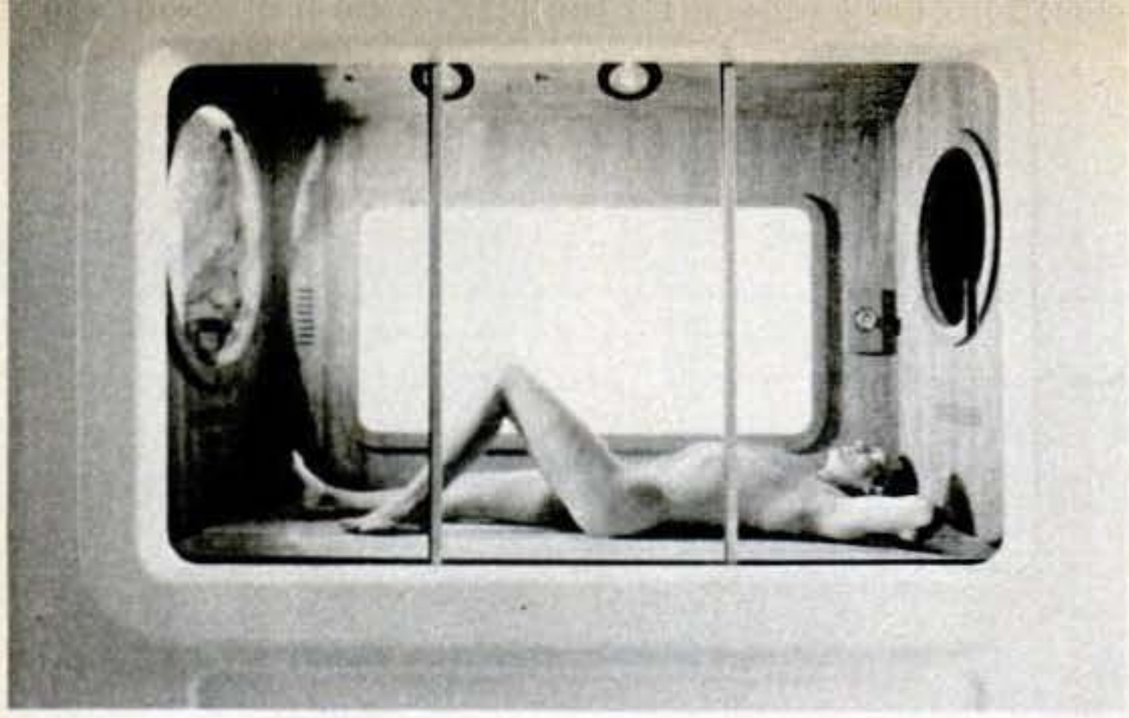

Weather machine

built into your bathroom

Recessed into bathroom wall, this alcove offers the warm relaxation of a private sunbath from four sunlamps plus four heat lamps in the ceiling. Photo below also shows half of the six sprinkler heads for those spring showers—and vent slots for those drying winds—that you can preprogram in a sequence of any duration you choose. Note rich teak cabinet and cypress deck, luminous panel, storage porthole with stereo speaker above.

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It offers the joys of sauna, steam bath, solarium, and shower for a mere $10,000

By E. F. LINDSLEY

Gratifying sensations ranging from desert sun to tropical rains and Chinook winds, with jungle steam in between, can be yours in a new self-contained, electronically programmed, synthetic environmental chamber for home use. "Environment" is its trademarked name, and it's now being made by the Kohler Co. Although its power consumption —four kwh for a full cycle—may cause the energy-sensitive among us to wince, once you've seen and felt Environment work, you may find it easy to swallow any initial resistance and start mulling over where you could install the unit in your own home.

About the size of a tipped-over phone booth, Environment has sliding acrylic doors to let you—and, even better, you and a partner—climb in and deploy comfortably on the preheated cypress deck. Once you're inside, pressing a button starts a sequence which you have previously set on an exterior control panel to suit your tastes for the time of each environmental event. A combination of overhead sunlamps and heat lamps lets you bask in sand-beach warmth or desert brilliance; later comes a warm rain from six 24-carat, gold-plated sprinkler heads; then benign jungle steam envelops your body and mind, ultimately yielding to spring rain; finally a drying Chinook wind drifts through Environment's teakwood chamber. You can go the full cycle—up to 29 minutes for each element—or skip certain elements altogether. An accessory sound system provides, if you wish, eight-track stereo music, or a programmed tropical storm.

It's all gentle—calculated to soothe, comfort, and be totally pleasurable. (There are no plans to add Arctic blizzard or California quake to the environmental sequence, though there's little doubt that Kohler engineering could meet such challenges.) The rain heads are not the hard-driving kind that would strip the bark off a log, and the rain temperatures will stay where you set them under thermostatic control. The overhead lamps don't bake you with sauna heat, and there's no worry about burning. Halfway through your sunbath a chime sounds, advising you to roll over for an even tan. If you doze off, your preselected sun time automatically ends with a gentle shower.

Granting the sybaritic joys inherent in Environment, I was intrigued by its mechanism and visited with John F. Mooney, director of group engineering for this and other projects at Kohler. He quickly shot down my suspicion that Environment had been dreamed up by someone who'd spent too much time staring at the washers in a laundromat. The controls—the result of long research, too proprietary to discuss in detail—are encapsulated, operate on 12 volts, and have LCD displays of the event times you select. They're definitely not upgraded washing-machine controls, but more than that, Kohler won't say.

"What kind of water supply do you need?" I asked. "How much water does it use? What pressure is required? What kind of wiring? What's the current draw? Isn't it an ideal breeding ground for fungus and bacteria?"

Mooney's answers were reassuring. "Your ordinary household water supply and heater are the basic supply; water usage during the rain cycle is about four gpm. Household pressure, whether from a 20-50-psi cycle off a well pump or from regular city pressure, is fine, since the rain heads are special industrial self-regulating nozzles made to deliver the same volume automatically over wide pressure ranges. Each head delivers 0.7 gpm. As for wiring, the service hookup is 50-amp/220V, but the heaviest draw is 28 amps during the steam cycle when the steam generator is on."

I was glad to learn how deeply Kohler had gone into the matter of bacteria buildup, since it seemed to me that the chamber could turn into a massive incubator. Actually, doctors have been checking rigorously for months (the demonstration chamber has been used by many persons), and they've found nothing; it appears that the ultraviolet and the steam keep things pure.

Thus, Environment is pretty much self-contained without special installation needs. One thing it has that you might not expect is a 30-second recirculating cycle to clear the cold water from the sprinkler-head pipes before the valves pop open. And valve-opening in production models will probably be by servo rather than solenoid, to taper the rain on and off gradually instead of in the present punctured-cloud fashion.

Since the ready-to-install Environment package costs $10,000 (a $3500 kit is in the offing for on-site assembly—it'll come in three cartons), questions about operating costs fall more or less into the "who-cares" class. For the record, and depending upon the cost per kwh where you live, Kohler says to expect about 25¢ for a typical 50-minute soak, wash, rinse, and dry cycle. It's cheaper, for example, than running a batch of clothes through an electric dryer.

Refreshing rain follows both heat and steam cycles. For Environment brochure, write Kohler Co., Kohler, Wis. 53044.

For ten big ones you should expect something special—and you get it. The interior is *built* of (not *finished* in) teakwood, planed and sanded from solid 1" stock. Teak exudes its own wax-like agent, resists ultraviolet light better than man-made synthetics, and is also better adapted to the constant wet/dry/heat cycles. Other woods tested over a long research period split and warped. The rich motif is enhanced by a 30"-by-60" luminous rear-wall panel that bathes the interior in soft light (as an option, you can even order this panel with an art nouveau painting). At both ends of the chamber are portholes. The smaller one is a cabinet for bath gear and tan lotion—it has its own sliding acrylic door. The bigger porthole can be a window to a terrarium, an aquarium, or—if the location of your Environment permits—the outside world. The front panel, resembling a massive TV-tube surround, comes in fiberglass in any of 14 colors.

I was surprised by the market Kohler expects for Environment. Health clubs, swinging singles condos, spas, and the like are naturals, but I was told that Environment is intended for the private home, either as a built-in or an add-on. The units are already in production, and you can plan on an eight-week delivery from the time you special-order yours through a plumbing wholesaler.

I mused on all this as I drove back from Kohler's Wisconsin headquarters. It does take some room, but—maybe if I moved the freezer over to one side in the garage . . . PS

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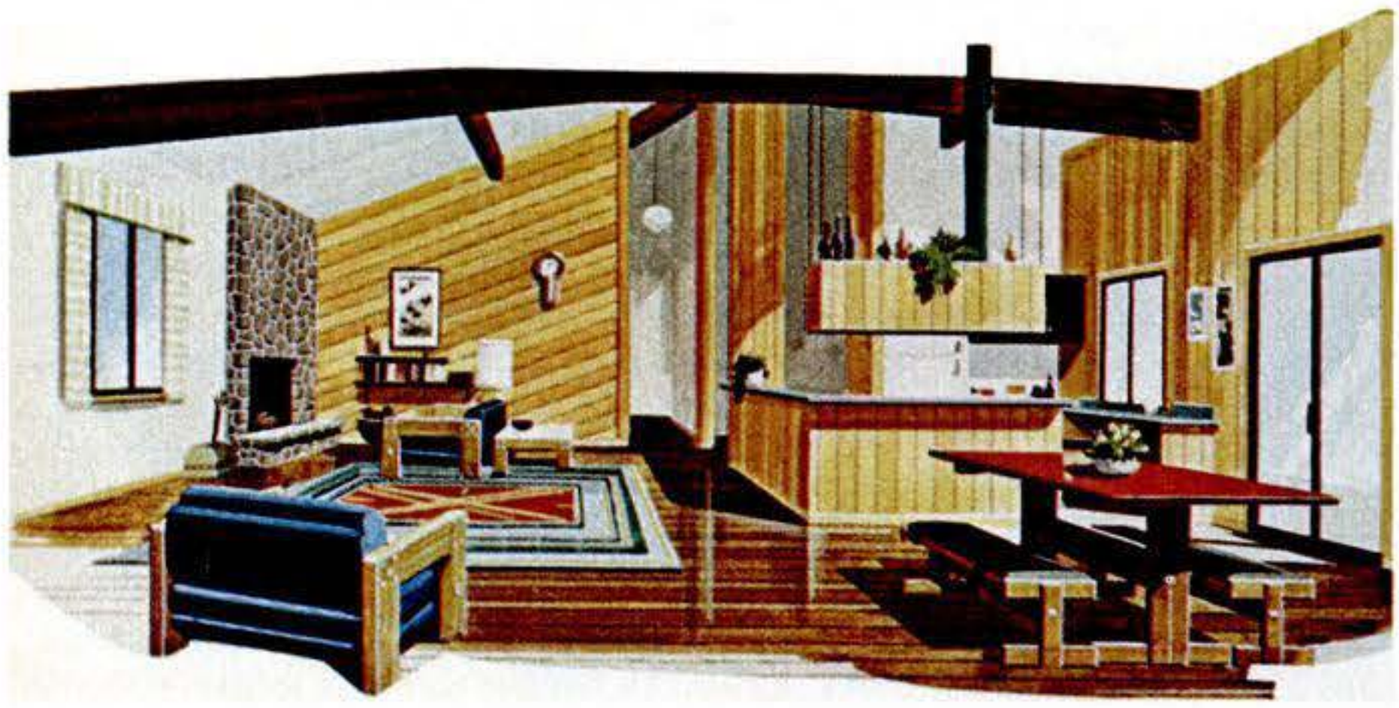
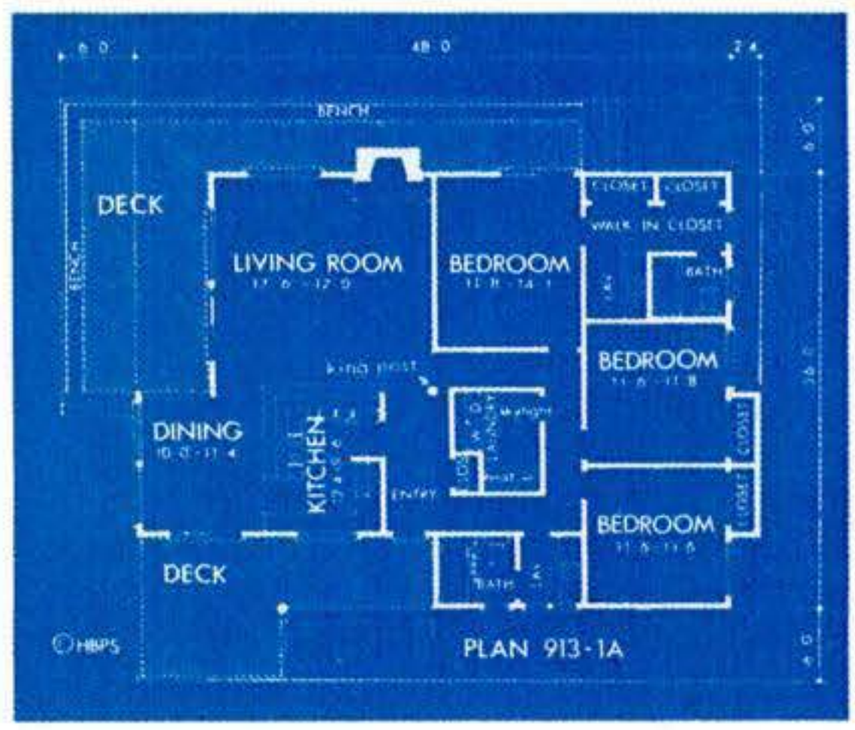
PS LEISURE HOME of the month

King-post pagoda



View of open-plan interior is from deck-entry steps (arrow on floorplan).



A vaulted ceiling, bowing down from a central king post to cap all rooms, produces the spacious interior in this open-plan cottage.

A massive fireplace (faced in stone or brick) dominates the living room, which also features accent walls of western wood board paneling sloping to the high center point.

Wide vistas are afforded through broad windows and sliding glass doors, both here and in the adjoining dining area. This glazing is shaded from the hot summer sun by deep roof overhangs.

The sliding doors also offer access to the enclosed deck of the dining alcove and to a large wood deck with a bench-railing that wraps around the living room.

The novel but highly functional kitchen is located at the heart of family activity. There's an eating bar along the window wall of the kitchen, and an L-shaped counter provides more than 16 feet of work space. The gap between the counter top and the cable-hung overhead cabinets gives a view into the dining room. (The flue rising from this floating unit vents a built-in range hood.)

The master bedroom has a walk-in closet that also provides access to a private dressing room and bath. Two other bedrooms, with generous closet bays, share the second bathroom.

The laundry and furnace room is the core of the house, contributing to heating and hot-water economy. The laundry area is brightened by a skylight. The traffic plan from the front entry eliminates cross-room traffic and circumvents this core.

Outside, the attractive styling features cedar shakes on the pagoda roof, and diagonal wood siding. The scoop of the roof peak is echoed in the chimney cap for the siding-faced fireplace chase.

This is another in a series of vacation homes designed for PS (in cooperation with Western Wood Products Assn.) by HBPS. Some customizing is available (see below). The basic plan includes a detached 22-by-24-ft. two-car garage in matching style.—*Al Lees*

How to order your plans

One set of detailed, professionally drawn blueprints, meeting new energy conservation and insulation requirements, is $60; four sets (for contractors, financing, and obtaining building permits) $75. Plans will be reversed, side for side, for $12; materials list, $10; plumbing and wiring diagrams, $5 each. Specify plan 913-1A. Address orders or inquiries to: Home Building Plan Service, 2235 N.E. Sandy Blvd., Portland, Ore. 97232.

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How to use a timing light

By WALTER KOEHLER

Proper ignition timing is essential to good performance and optimum mileage. If your car has an electronic ignition system without breaker points, you can usually forget the timing once it is set, unless knocking occurs. But in cars with breaker points inside the distributor (most cars on the road still have them), wear on the points' rubbing block changes the point gap and affects ignition timing.

Ignition timing should be checked at every tuneup and adjusted if necessary. Setting timing is a simple job requiring a few hand tools and a timing light—plus a dwell-tach or tachometer by itself. The timing light is the key to the operation. It's a stroboscopic light connected to the spark-plug cable of your car's number-one cylinder.

Each time the spark plug fires, the light flashes. If the engine is running at 600 rpm, each cylinder fires 300 times a minute (five times a second). The rapidly flashing light is pointed at the crankshaft pulley and appears to stop it, so the timing marks and reference mark can be aligned.

Timing lights cost from about $5 to $60 (for a professional model). A typical low-priced unit uses a neon tube, which does not produce the brilliant flashes generated by the xenon tubes used in more expensive models. With the latter type, the timing marks are visible even in a brightly lighted area.

Timing lights are sold at auto-supply stores, department stores, and major chains such as Sears. The best source for a professional model

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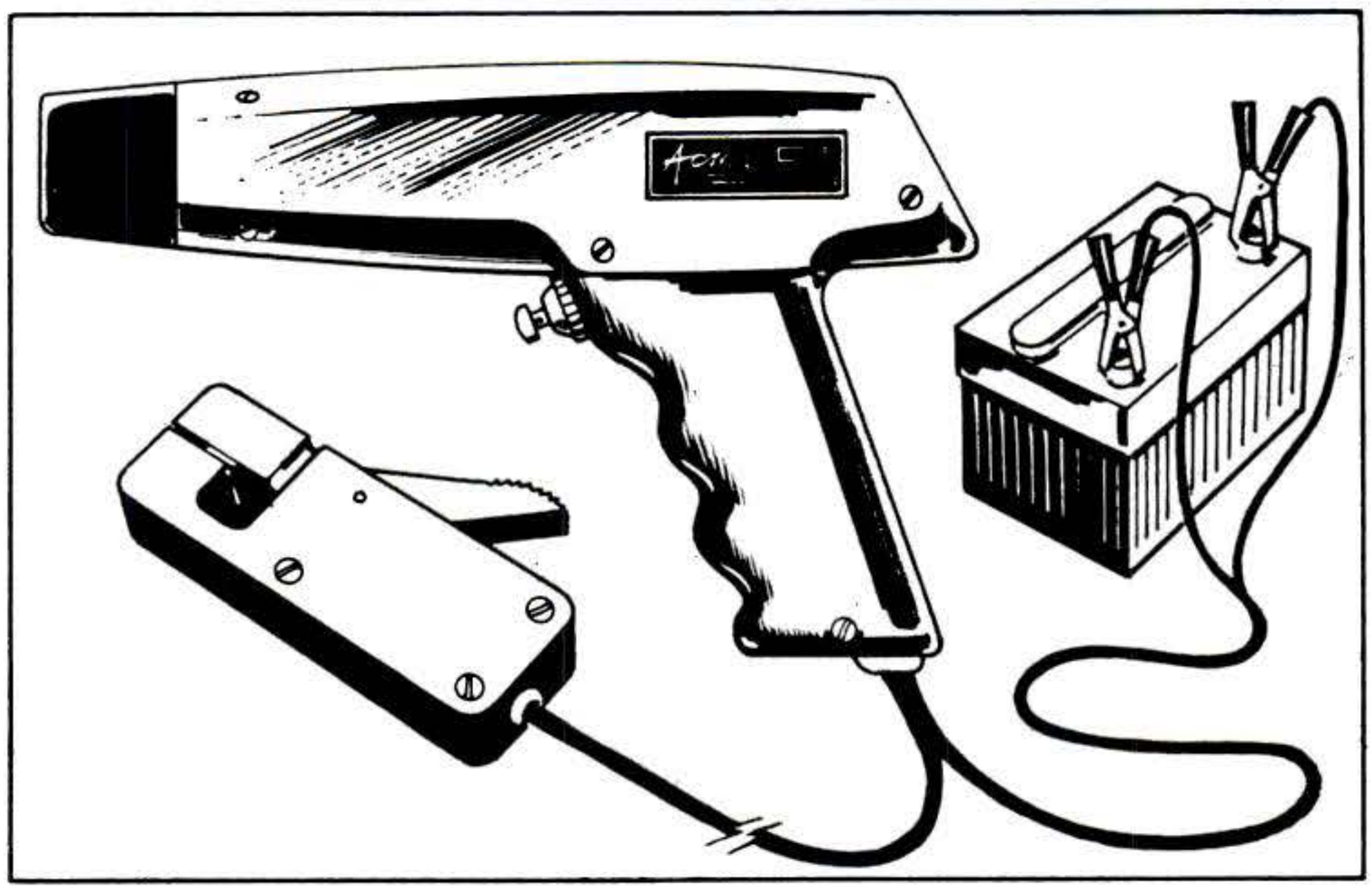

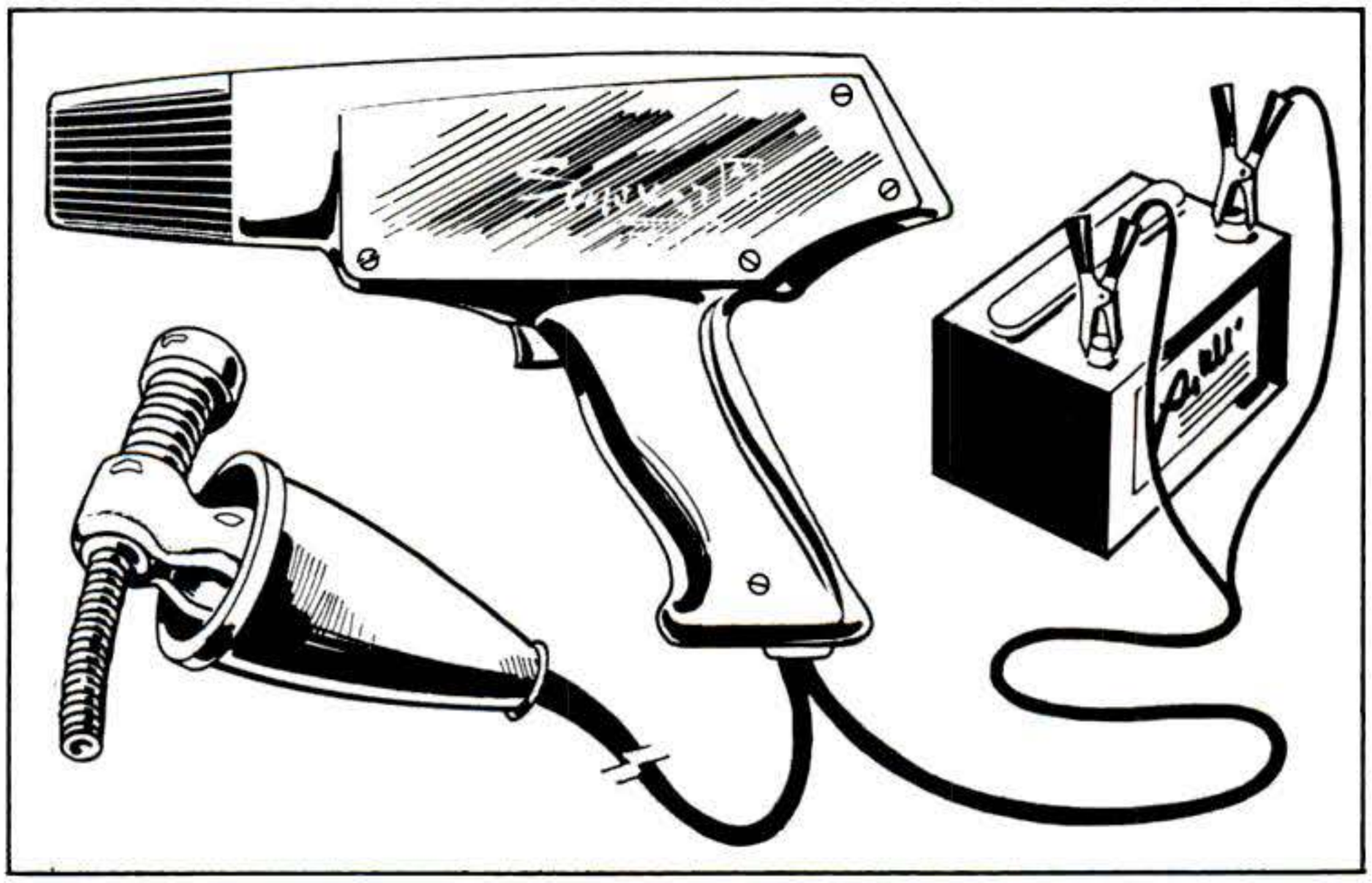

Timing light with inductive pickup is shown at top. To use it, just clip the pickup around the spark-plug cable; no need to remove the spark-plug wire. With light in lower sketch, you remove the plug wire, and the wire coil (held by alligator clip) fits between the spark-plug boot and the spark plug.

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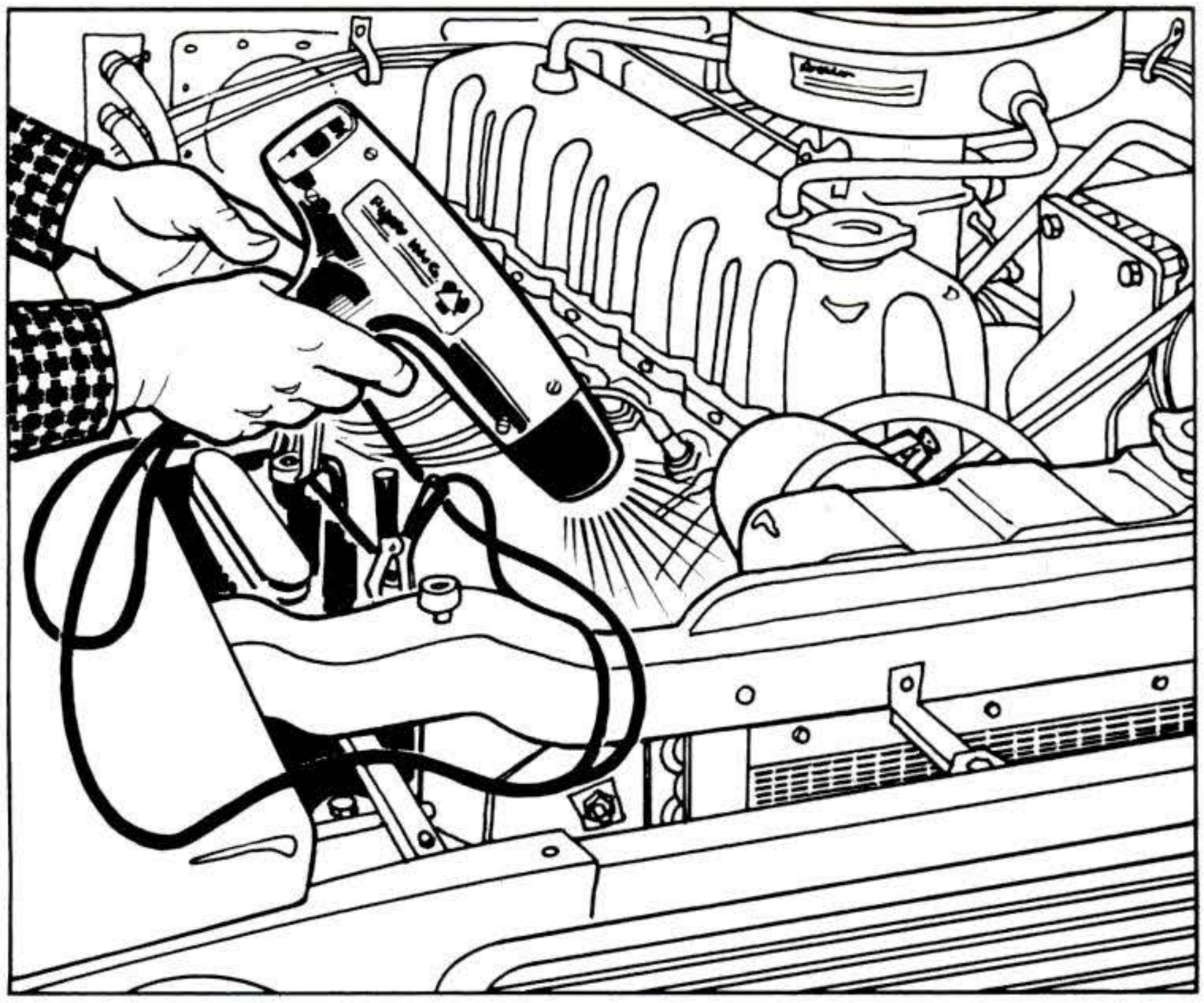
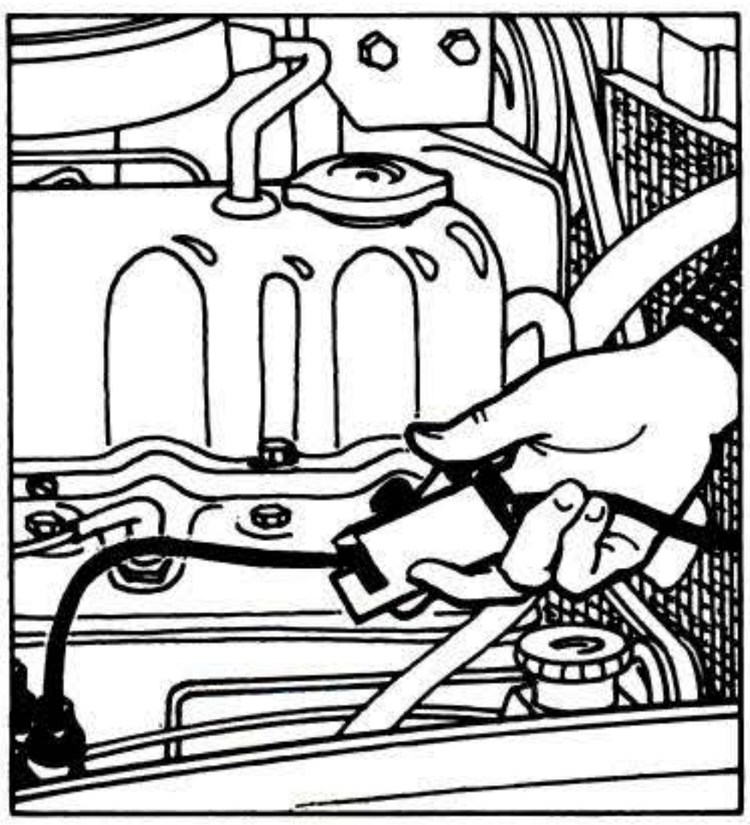
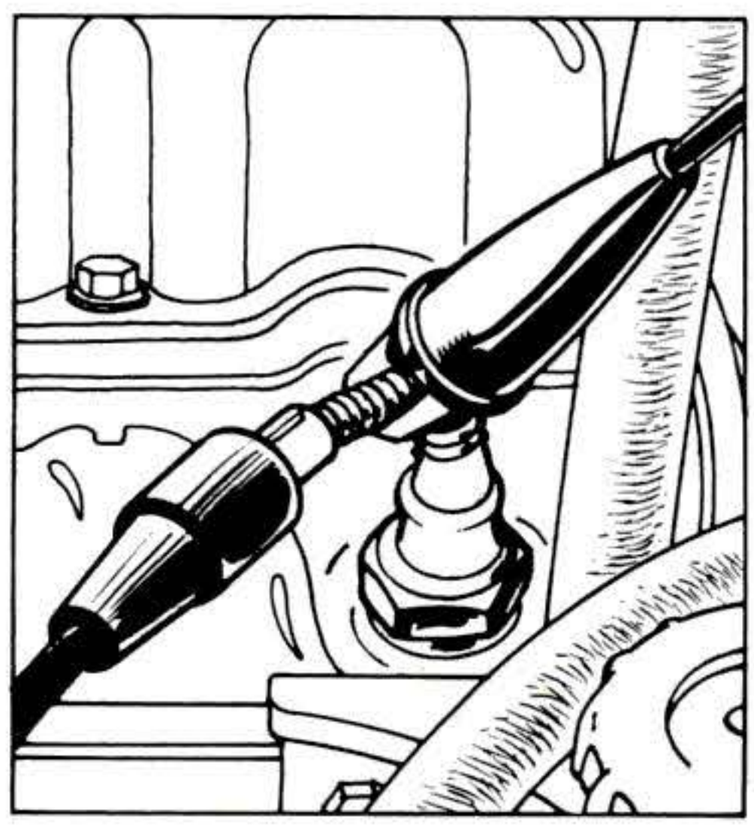


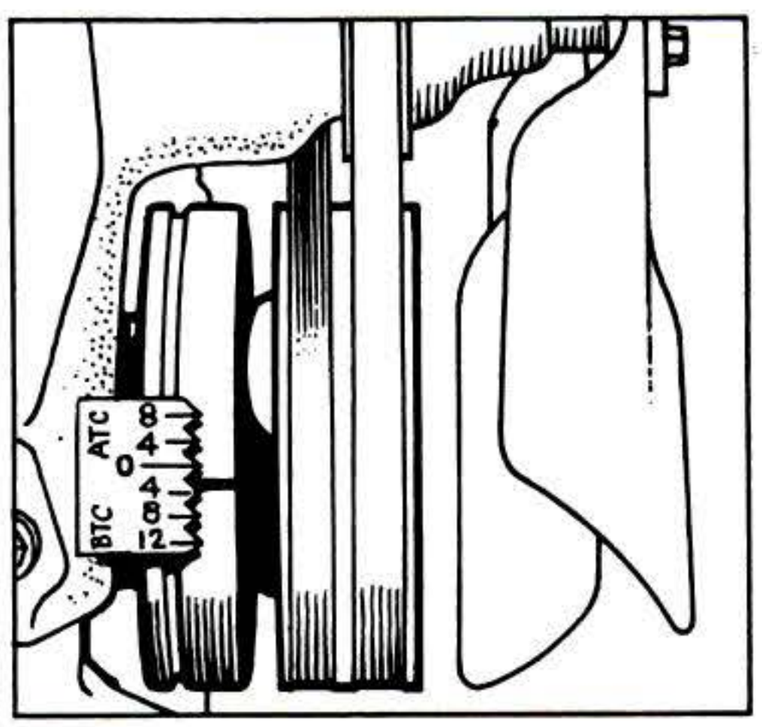
After adjusting idle to specifications called for in shop manual, plug the vacuum line (if specs call for it) and aim light at timing marks.



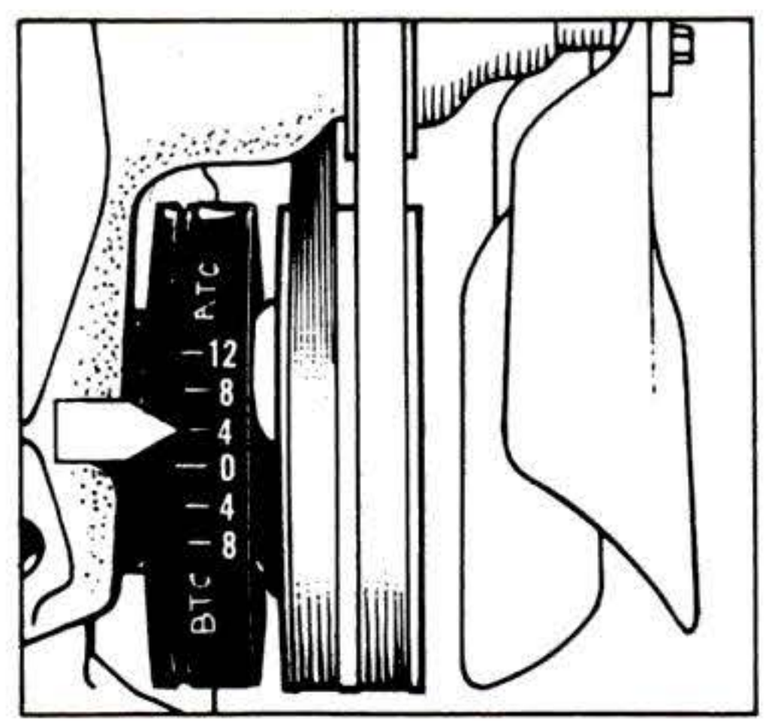
This is how inductive pickup clamps onto number-one wire without piercing.



This type of hookup requires the plug wire to be removed to insert wire coil.



Timing scale attached to engine and reference mark on the damper pulley look like this in some cars. Make a chalk mark on both scale and reference mark.



Here, timing scale is on damper pulley and the reference pointer is attached to the engine. Again, mark the pointer with chalk, and mark timing scale.

is an automotive jobber: Try the yellow pages under "Automobile Parts and Supplies—Wholesale." Or ask your local mechanic. The jobber's primary market is the service trade, such as repair shops and service stations, but most will also sell to retail customers.

All timing lights are easy to hook up. Instructions with the light will tell you how. A light with an inductive pickup is the easiest to install. Regardless of which light you buy, you always hook it up to the number-one spark-plug wire.

On all American-made in-line engines, number one is the cylinder nearest the front of the car. On other engines, consult a shop manual for the location of number one.

Timing, step by step

First step in the timing operation: clean and mark the timing marks so you can see them. Check the sketches here to see which pointer system applies to your car. Clean the timing marks and reference mark with a cloth, or if the area is really dirty, with a bristle brush.

The timing scale usually has 0 or the letters TDC at the center and a series of lines, usually in increments of two or three degrees in each direction, as in the drawings. If specifications in your shop manual call for ignition timing to be set at, say, 12 degrees BTC, take a piece of white chalk and mark along the 12-degree line on the BTC ("Before") side of 0. The other side of the scale will be labeled ATC or "After." Also mark the pointer or reference slot with chalk.

If your car has breaker points, hook up a tach dwell according to instructions provided with the instrument. Adjust point-dwell to specs. Next set idle to the speed specified in the shop manual for ignition timing. With electronic ignition, a tach-dwell is unnecessary. A tachometer can be used to set idle speed.

Now, with the engine shut off, hook up your timing light. Be sure all leads are clear of the fan and belts. Usually you should disconnect the vacuum line at the distributor and plug it. Check your shop manual on this.

Next loosen the distributor hold-down nut just enough so you can turn the distributor by hand, but don't turn it yet. With the parking brake on, place the gear selector in the position called for by your shop manual. If the manual doesn't say, put the gear selector in neutral. If your car has A/C, refer to the man-

[Continued on page 176]

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Build your own timing light from a kit

Finished light in action, left. It looks good, works well, and is housed in a sturdy plastic housing. It is polarity-protected, so if you hook it up to your battery incorrectly it won't be damaged. You can order it from Heath Co., Benton Harbor, Mich. 49022.

By RAY HILL

I already have two timing lights, so I didn't really need another. But when I learned that Heathkit was offering a battery-powered model with a xenon flash bulb and an inductive pickup that snaps around the plug wire—well, I just couldn't resist.

The price is right—$29.95. That's cheaper than some equivalent lights. I'd never put together a timing light before, nor had I ever assembled a Heath kit. So I figured I'd find out if these kits really are as easy and fun to assemble as I'd heard, learn a little about how a timing light works, and add another quality light to my collection—assuming everything worked out.

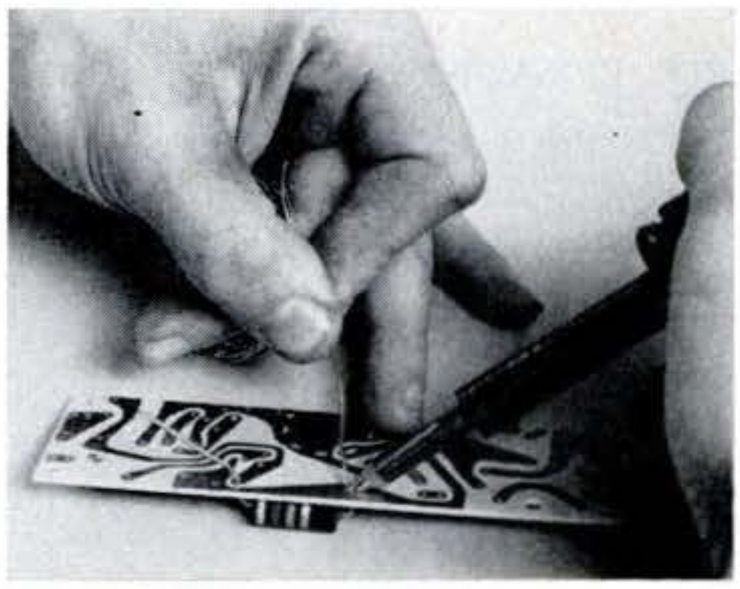
After the box arrived and I dumped all the parts out on my workbench, I wasn't so keen about my education. That looked like a lot of parts. How, I wondered, do you feel when you uncrate the pieces for a TV set?

But after opening the assembly manual and following its instructions I began to lose my initial fear of botching the job. The manual is so well written and illustrated that it's almost impossible to go wrong. But if by chance you do foul up, or a part malfunctions, there's a troubleshooting section also.

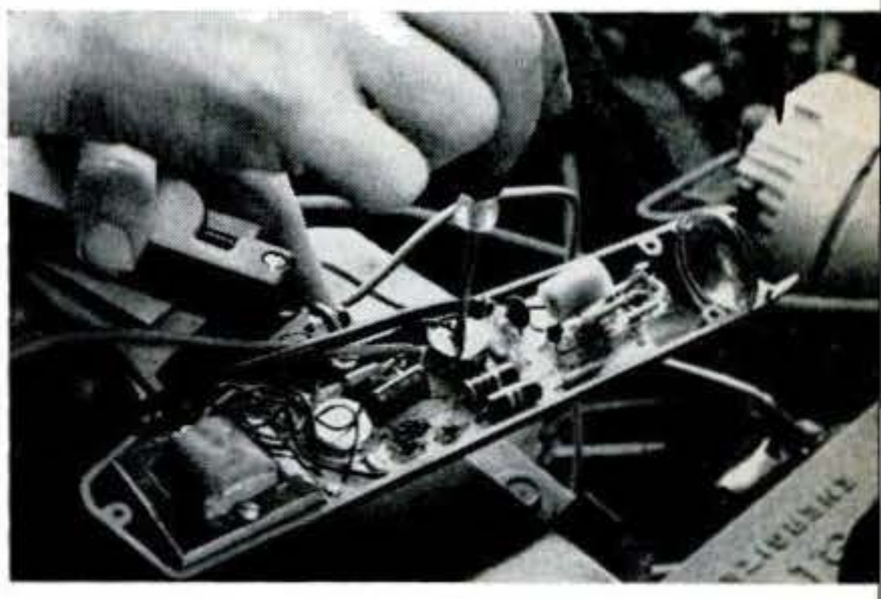
In case you've never soldered a circuit board before—or even if you've never soldered anything—the kit includes instructions on how to solder. Solder is even provided.

I started assembly at two o'clock one afternoon and finished at nine o'clock that night. My wife literally had to pull me away from my workbench. That, I understand from veteran kit builders, indicates a weakness: Serious kit builders don't stop for anything, even sleep.

Although the instructions were faultless, and I had done what I thought was a workmanlike job of assembly, it was with a nagging fear that I headed out to my car to see if the light would work. I hooked the red alligator clip to the positive battery post, the black alligator clip to the negative post, and clipped the inductive pickup to the plug wire.



First step in assembly is to solder this resistor to the circuit board. After soldered joints have cooled, excess wire ends of resistor are snipped off.



Final adjustment of light is made with it hooked up to a power source. Then other half of cover is screwed on and you're ready to see if it works.

With inductive pickup for number-one spark-plug cable, you save the hassle of removing the spark-plug wire. Pickup grips wire lightly, doesn't puncture.

I put the light on the fender with leads clear of the fan and reached in to start the engine. Then I pointed the light at the timing marks on the damper pulley, and pulled the trigger. The light flashed!

My next kit is going to be a battery charger. I've already got one of those, too. PS

Backyard fountains

Both ornamental pools are easily made from lowly tanks

Septic-tank fountain

I'd never poured any concrete, so for years I backed off when my wife mentioned her dream of a fountain and fish pond in our backyard. But last year I got smart: I called the local makers of septic tanks and told them just what I required.

I knew that for fish to survive the winter, an outdoor pool should be at least two feet deep. So I special-ordered a metal tank three ft. deep and 5½ ft. in diameter. I told them to rust-proof the outside as if it were a septic tank—but warned them not to touch the inside, for the sake of the fish. The treatment should protect it for years. Cost of the tank: $100.

At home, I cleaned the inside with vinegar and applied a coat of latex metal primer. A high gloss, nontoxic (again, for the fish) enamel went on for the top coat.

The rest was easy. I sank the tank into the yard, its top edge flush with the surface. I dug a circular trench, poured in a footing collar, and laid bricks in a circle lapping the tank's edge. (I left a small hole between footing and bricks at the back for an electrical cord.)

I painted a 2½-ft. long, 16-in.-diameter metal culvert ($10) with the same paint used on the inside of the pool. Stood on end in the center of the pool, it supports the statuary and fountain ring. A submersible pump and two underwater lights completed the pool. As a backdrop, I erected a bowed wall of lightweight shale blocks and put two outdoor lights and shrubs at its base. A timer controls the operation.—*Charles Stem*

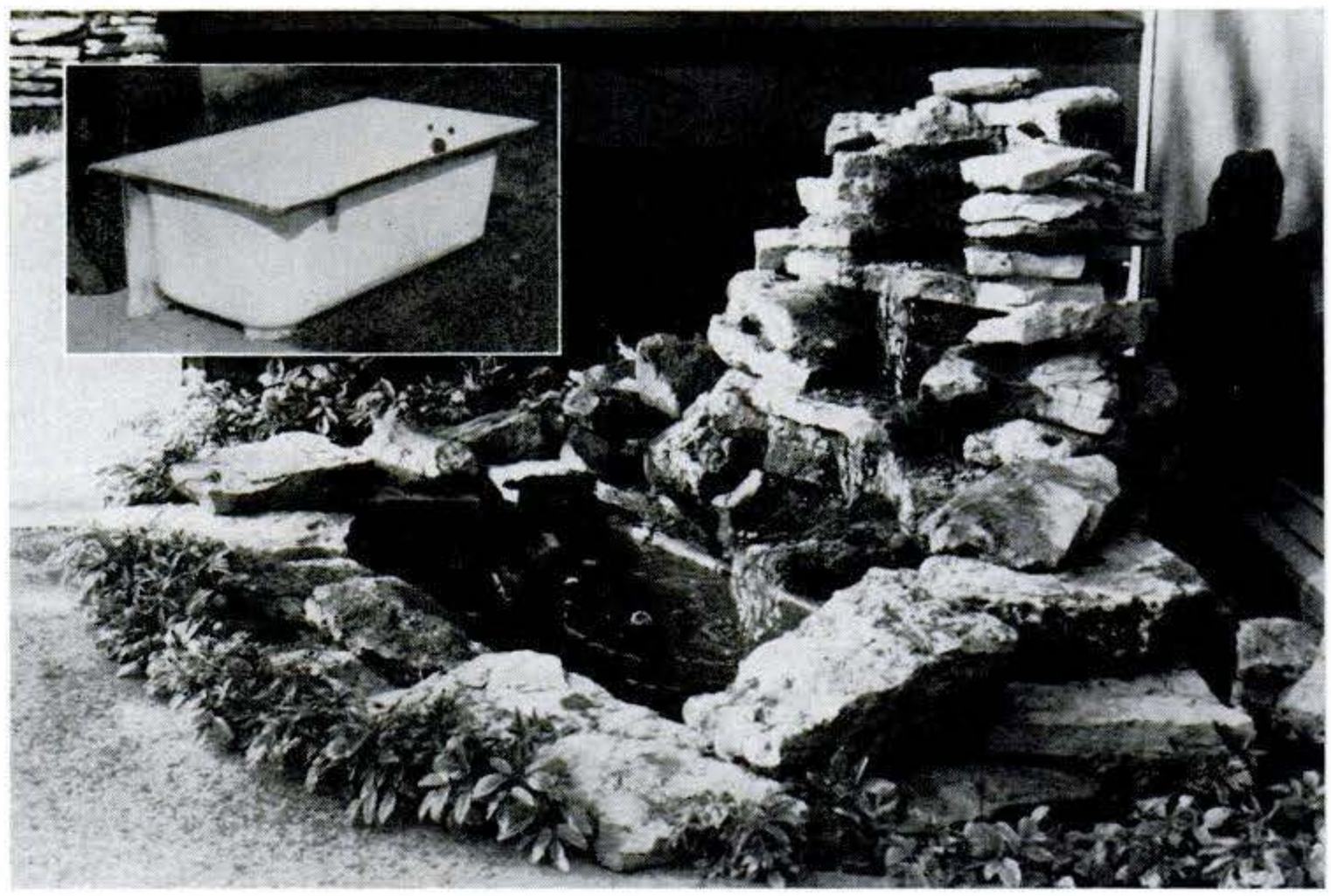
Bathtub waterfall

The key to this project is an old bathtub you can probably find, as I did, in the junkyard of a local plumber. He may even donate it to you.

Before sinking the tub into an area next to my house, I gave the outside a protective coating of asphalt paint. After plugging the drain hole with a standard rubber stopper, and the faucet holes with wooden plugs, I sealed them from the back with concrete. The center spigot hole serves as an opening for a water-pump hose. I also sealed this hole with concrete after the pump was placed in the tub and the hose had been set into its final position.

With the tub in place, I laid field stones around the rim and stacked them up behind. To channel the miniature waterfall, I worked in four slightly concave flagstones at appropriate levels.

After this stonework was completed, I coated the interior of the tub with turquoise epoxy spray paint.



The pump hose, drawn up behind the waterfall, can be hidden by more rocks. Field stones inside the tub mask the pump, hose, and power cord, and provide a hiding place for the fish.

The plastic hose that came with my pump cracked in our freezing Wisconsin climate, so I replaced it with a Neoprene hose, and have had no trouble since. I installed an electric stock-tank water heater that we plug in periodically during the winter to prevent too thick an ice cap from forming. The fish live on.—*William Gerler*

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*Note: Some participating stores may not stock all items shown.

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City _____ State _____ Zip _____

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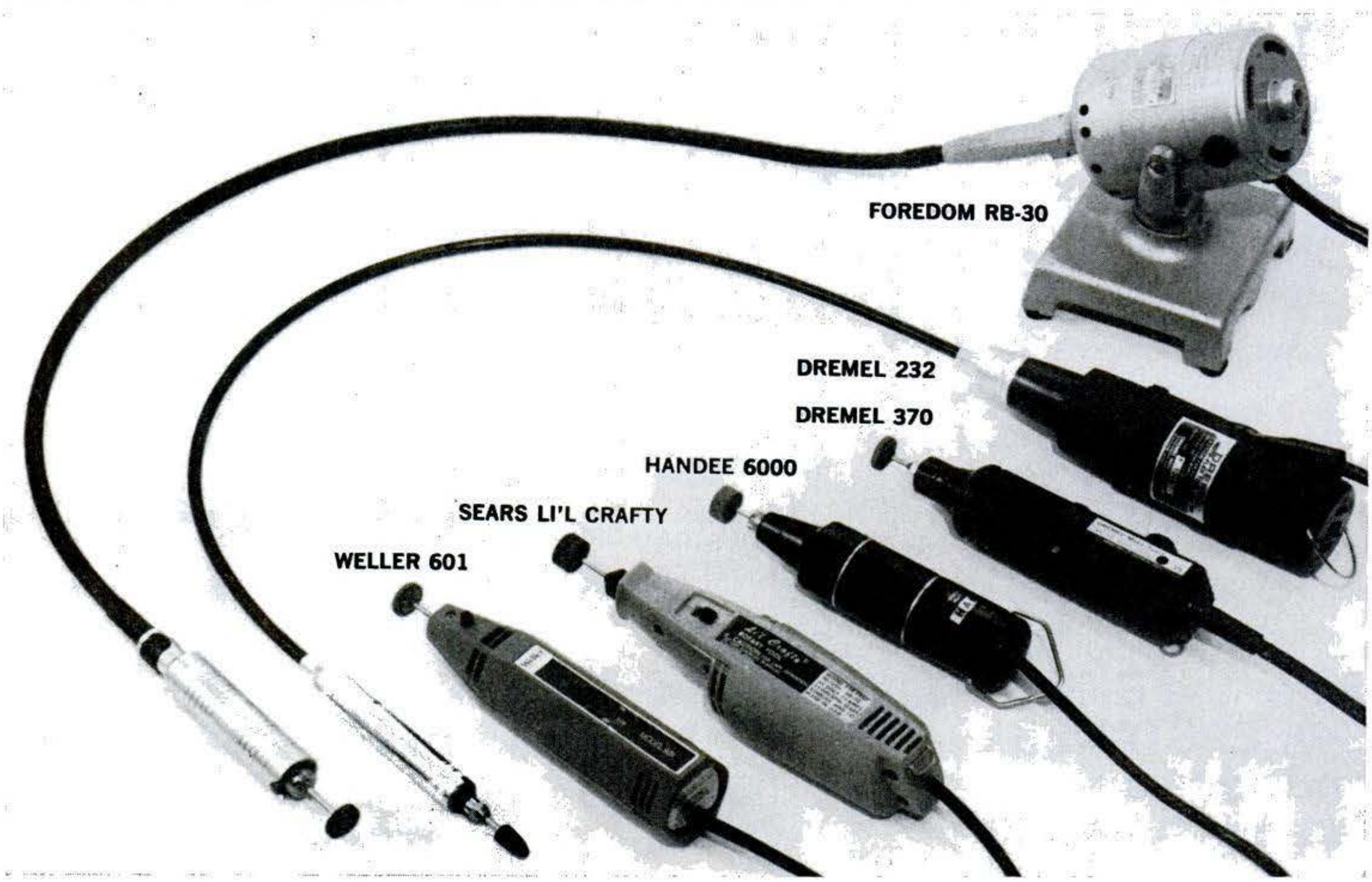
SPRING
Home Value Ideas

Beginning here: a special section for today's breed of homeowner

A milestone was reached last year in sales of building materials for home maintenance and improvements: Over half the total volume went directly to us DIY'ers. Always before, we'd accounted for a smaller part of the market than professional contractors, plumbers, painters—and some manufacturers weren't all that keen for our business. Never again: From now on, our special needs will be catered to more and more, in terms of packaging and how-to instruction. All of which makes for happy times at your local home center or hardware store. We join the celebration with a special group of articles on tools and materials, flagged with the symbol at left.



Hand grinders
—versatile tools for your shop

What is a hand grinder good for? More to the point, what are all those add-on burs, bits, cutters, wheels, points, discs, wire brushes and cotton wheels good for? And why spend $106 for a flexible-shaft hand grinder with interchangeable handpieces when you can buy a hand-held model complete with accessories for $50? Here are the answers you need to make the right buy.

A hand grinder, although intended primarily for light grinding and craft work, may well be the most versatile tool you can have in your shop. Accessories in a wide variety of types, sizes, and shapes enable you to grind, sand, polish, buff, deburr, engrave, carve, rout, and saw most metals, glass, ceramics, minerals, wood, and plastics.

Hand grinders are made in two basic styles: hand-held with the motor and tool-bit chuck in one housing; and flexible-shaft, where the motor rests on the bench or hangs on the wall, with the tool bit chucked in a small handpiece attached to the motor by a flexible shaft.

Both styles are high-speed tools compared to most other shop tools. Hand-held types have no-load speeds up to 30,000 rpm; flexible-shaft types run 14,000 to 20,000 rpm. For most jobs, the tools should be run at about their no-load speeds, but lower speeds provide better control for some operations such as sanding.

Hand grinders have universal motors that are either wound or permanent-magnet, and are generally AC/DC. The single-speed, hand-held units and the Dremel Model 232 flexible-shaft tool (see chart) can be speed-regulated with simple sewing-machine-type rheostat foot controls, or with small solid-state speed-control units such as the Dremel 217 and 219 foot-operated and table-top models. Foredom tools require Foredom speed-control units.

Hand grinders are sold with accessory kits that include enough bits to get you started. (Most hand grinders

Continued

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How to convince your wife that sawdust isn't dirt.

You could show her a four-sided taper, of course. Or a locked rabbet miter. A tongue and groove. Even a true tenon.

But she'd probably yawn.

What it really takes is something she's always wanted. Like the new kitchen she's always needed.

And what that takes, we don't have to tell you, is a tool designed to do all of the above and then some. To perfection.

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A depth capacity that's good and deep. Up to 3¼ inches at 90 degrees, and 2⅛ at 45.

A heavy-duty, overload-protected, ball-bearing motor that puts out a whopping 2½ horsepower.

And possibly the best reason of all, $254.99.*

What it buys you, besides some other nice features like a self-aligning rip fence and a mighty sturdy stand, is one heck of a saw. As good as you could ever want, short of actually having our big industrial equipment.

The only reason for that is just plain good engineering. The kind that only comes with half a century of experience and on-the-job performance.

It goes into all seven of the table saws we make, from our $179.99* nine-inch model on up. And into our radial-arm saws, band saws, jointers, drill presses, lathes, wood shapers and so on, on down to our ⅜-inch drills.

It's why they're all tough, and accurate, and powerful. Regardless of price.

Now, that may not impress your wife. But since you're the one who has to build the kitchen, we thought you ought to know.

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Rockwell. It's the same name industry's been depending on for 50 years.

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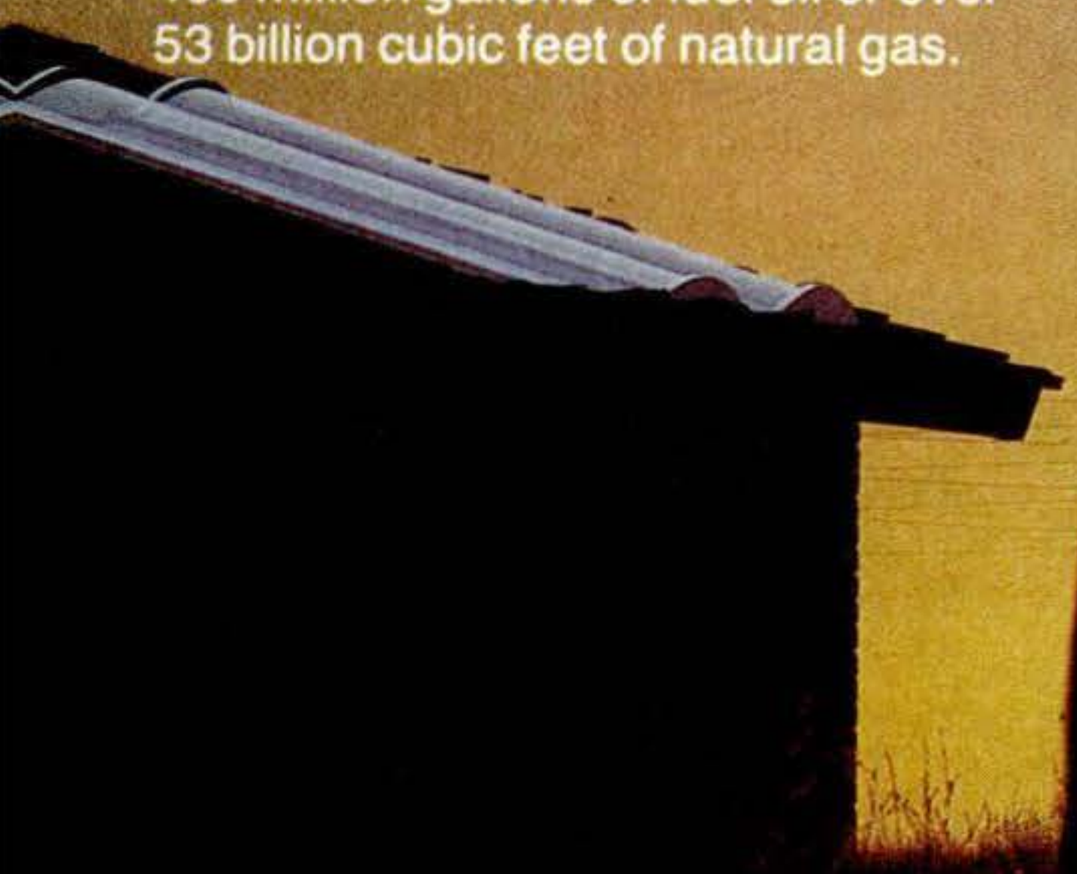

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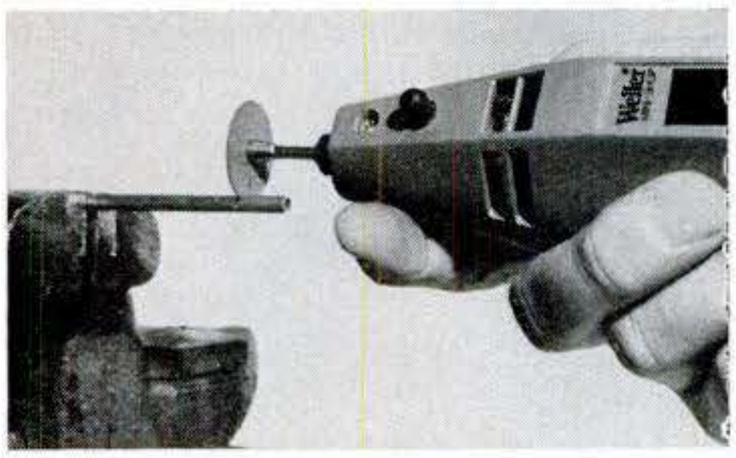
are also available separately at a lower price.) Accessories are usually interchangeable among brands.

Older hand grinders weren't noted for their power, and had to be used gently to prevent stalling. Today's hand-held types, particularly those with permanent-magnet fields, have much more torque and can be worked harder. Permanent-magnet types also hold a steadier speed under varying loads than do wound-field units; they also run cooler, as no electrical power is dissipated in the field.

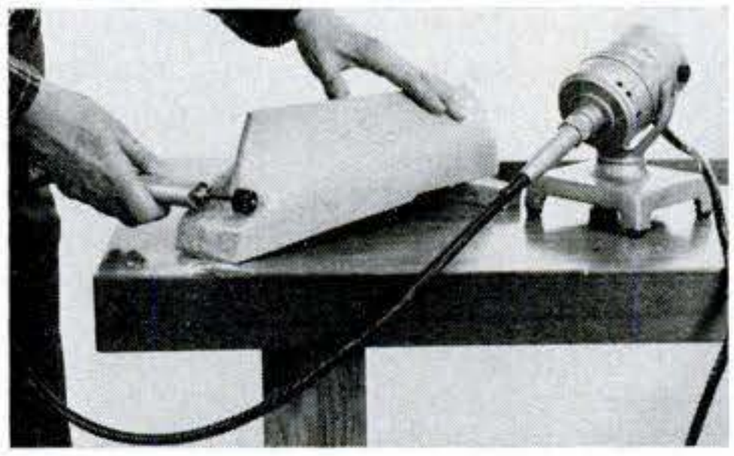
For general in-shop, hand-grinder operations, particularly when you're sitting at a bench or table, the single-speed hand-held models are best. Variable speed can easily be obtained with a foot control. Hand grinders with built-in solid-state speed control require that you stop working to change speed. You must also adjust the speed setting each time you change one of the bits, because the speed control is built into the ON/OFF switch.

Flexible-shaft hand grinders have higher power than hand-held types, are easier to manipulate, and are less fatiguing in long work sessions. This is true for relatively heavy-duty work as well as for intricate wood carving or plastic engraving.

You mount bits and accessories in all hand-held hand grinders (and most handpieces) by means of a collet —much as equivalent items are mounted in the chuck of a drill. Collets are not interchangeable between brands, nor are all collet sizes available in all brands.

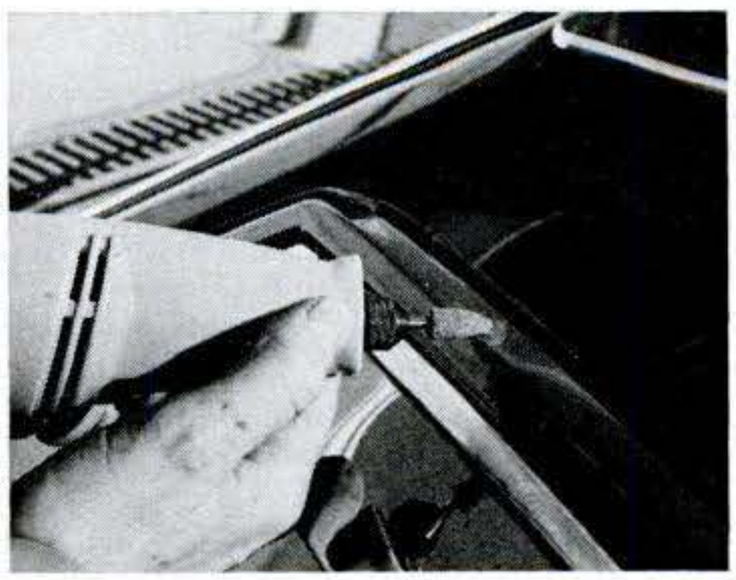


Abrasive cut-off disks are used for sawing and slotting. Here, a disk cuts thin-walled brass tubing. Wear goggles: disks are fragile.



Drum sanders are used for curved areas; they leave a semifinished surface. Foredom model here accepts ¾-by-½-inch drum.

Dental bur is useful for fine detail work on small handpieces. Rough edges are smoothed from this sand-casted cap badge.



Abrasive wheel can be used to remove rust. Maximum safe speed is set by wheel and mandrel diameter, wheel shape, overhang.

Abrasives and disks

Abrasive wheels and points can be used to grind a wide variety of metals, porcelain, glass, ceramics and gemstones, but not woods or plastics. These accessories are made of either aluminum oxide or silicon carbide; each abrasive, identifiable by color, has specific uses.

Silicon-carbide wheels are either green or black-gray, and are second only to diamond in hardness. They are more brittle than aluminum-oxide wheels. Silicon carbide is used for

Continued

How hand grinders compare

	Manufacturer and model	Price ($) (tool only)	Price ($): motor & kit no.		No-load speed (rpm)	Motor type	Power rating	1/32	1/16	3/32	1/2	5/32	3/16	7/32	1/4
HAND-HELD	Dremel Mfg. Co.														
	Moto Tool Model 260	29.95	37.95	261	30,000	Magnet	0.5A	*	*	*	*				
	Model 270	34.95	44.95	271	30,000	Magnet	0.8A	*	*	*	*				
	Model 280	39.95	49.95	281	30,000	Magnet	0.9A	*	*	*	*				
	Model 370	44.95	54.95	371	5000-25,000	Magnet	0.8A	*	*	*	*				
	Model 380	49.95	59.95	381	5000-25,000	Magnet	0.9A	*	*	*	*				
	Chicago Wheel & Mfg. Co.														
	Handee Model 6000	38.00	50.50	6010	28,000	Wound	50W		*	*	*				
	Model 6000PM	41.00	53.50	6010PM	30,000	Magnet	0.6A		*	*	*				
	Model 6000PMS	56.00	68.50	6010PMS	5000-30,000	Magnet	0.9A		*	*	*				
	Sears, Roebuck & Co.														
	Li'l Crafty 758. 25161	n.a.	37.99	n.a.	24,000	Wound	0.75A			*	*				
	Weller (Cooper Industries)														
	Mini-Shop Model 601	n.a.	49.95	n.a.	28,000	Magnet	1.1A	*	*	*	*				
FLEXIBLE-SHAFT	Dremel Mfg. Co.														
	Moto-Flex Tool Model 232	59.95	n.a.	n.a.	20,000	Wound	1A	*	*	*	*				
	Foredom Electric Co. (With No. 20 adjustable chuck handpiece)														
	Motor Model CC 30	106.00	109.50	(Kit 2272)	0-14,000	Wound	0.1 hp			No. 30 adjustable key-type general chuck handpiece for all size accessories from No. 80 drill up to 5/32 in.					
	Motor Model MM 30	126.00	Accessory kit No. 10 ($9.95) available separately		0-14,000	Wound	0.1 hp								
	Motor Model MMG 30	146.00			0-5000	Wound	0.1 hp								
	Motor Model R 30	136.00			0-14,000	Wound	0.1 hp								
	Motor Model RB 30	146.00			0-14,000	Wound	0.1 hp								
	(With No. 44A collet handpiece)	Deduct 3.00						*	*	*	*	*	*	*	*
	(With No. 55 contra-angle handpiece)	Add 21.00							*	3/32 short-shank latch dental accessories only					
	(With No. 5 handpiece)	Deduct 14.00						*	*	*	*				
	Motor Model 1	--	79.50	(Kit 3272)	0-14,000	Wound	1/15 hp								

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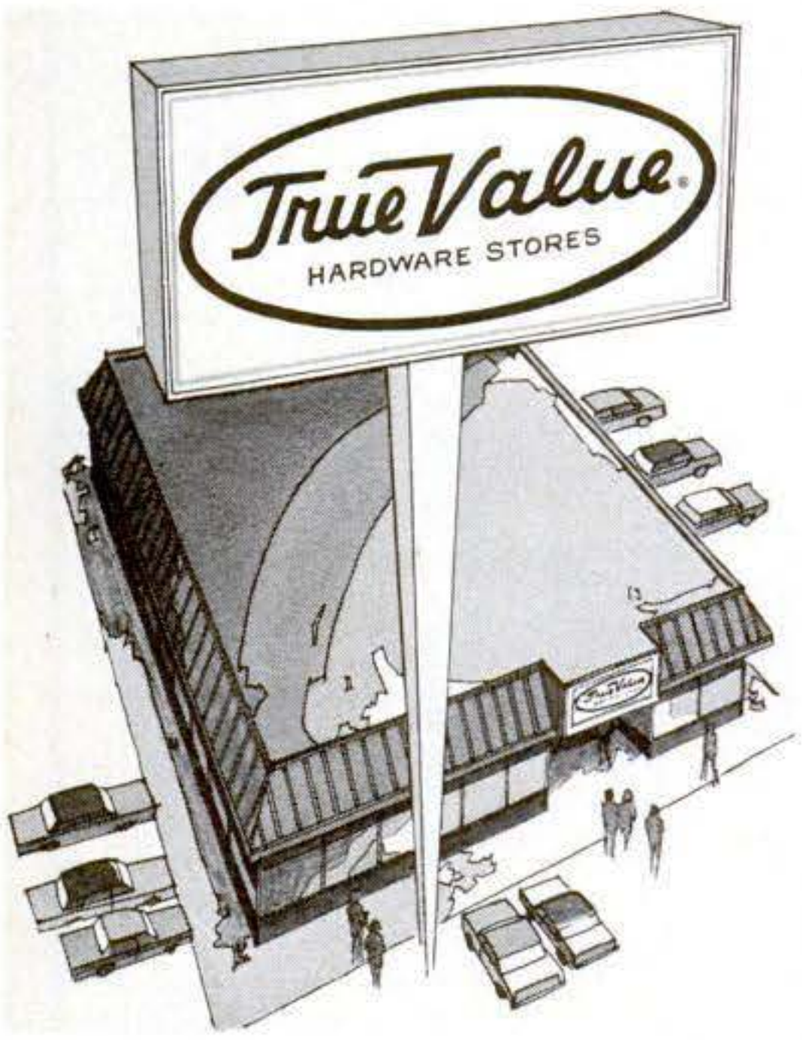
Take advantage of GE's special offer at low True Value Hardware Store prices. (See opposite page.)



There are over 5,000 True Value Hardware Stores in 50 states. Look under "Hardware" in the Yellow Pages.

grinding low-tensile-strength materials such as gray iron, brass, soft bronze, copper, and aluminum; and for stainless steel, glass, gemstones, and ceramics, both green and fired.

Aluminum-oxide (also called corundum or emery) wheels are usually brown, and are softer—but tougher—than silicon carbide. They are used for grinding high-tensile-strength materials such as carbon steel, high-speed steel, malleable iron, and porcelain.

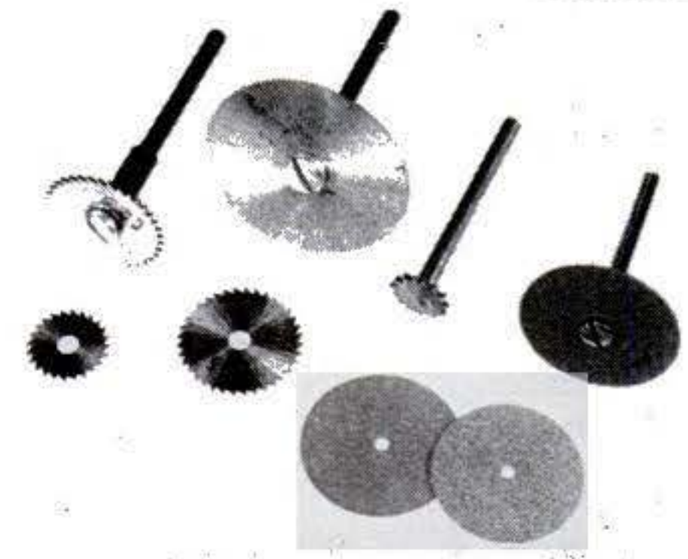
White aluminum-oxide wheels have extremely fine grit (400) and are used for producing fine finishes on high-tensile-strength materials.

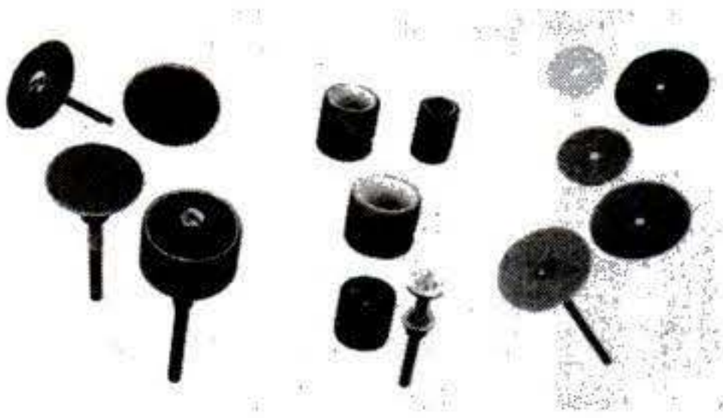
Four sizes of sanding disks can be used with hand grinders: 1/2, 5/8, 3/4, and 7/8 inch. They come in coarse, medium, and fine grades, usually 50, 80, and 120 grit. The two smallest sizes are handy for getting into tight places; they are available from dental-supply houses. Quartz (light tan), aluminum-oxide (brown), and silicon-carbide (dark gray) abrasives are used. Disk backing is usually light or heavy paper, but you will occasionally run into cloth-backed disks.

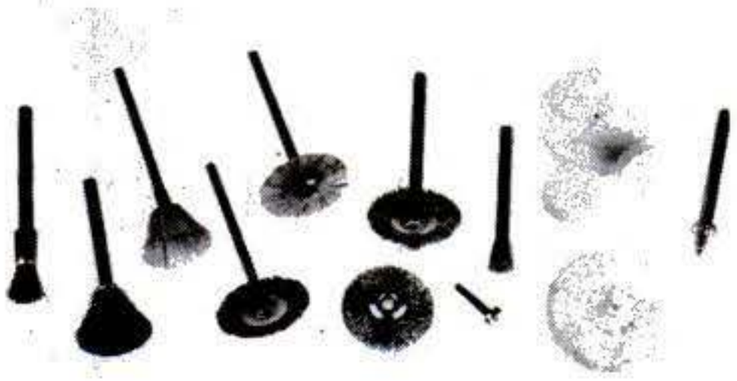
Abrasive bands for drum sanders are also made in coarse, medium, and fine grades. Two sizes are available for all grinders: 1/4- and 1/2-inch diameter, both 1/2-inch long.

Cutters and burs are similar, but cutters have 1/8-inch shanks and are machine-shop tools; burs have 3/32-inch shanks, the diameter required for dental drills. (Burs are also sometimes called engraving cutters.) Cutters generally come in larger sizes than burs and have coarser teeth. Cutters for hand grinders range as large as 3/8-inch diameter, while burs can be obtained as small as 1/32-inch diameter. Between these sizes there is a good mid-range size overlap.

Continued







Grinder brushes, from left: end, cup, and wheel bristle brushes; wire wheels, felt and cloth polishing wheels; threaded mandrel.

Accessories you can chuck into a grinder

Steel and abrasive saws (top photo, above): toothed saws are used to cut wood, plastics, and soft metal. Thin abrasive disks are used for slotting and harder metals. Sanding accessories (center photo, above): from left, sanding disks with screw mandrel; rubber-drum mandrel; sanding bands; Foredom 3/4-inch drum sander; disks held on rubber mandrel with tacky adhesive; sanding disks. Photo directly above shows wide range of abrasive wheels and points.

High-speed steel cutters (upper left) are examples of many available shapes. Long-shank and latch-type burs (left) are compared with typical cutter at right.

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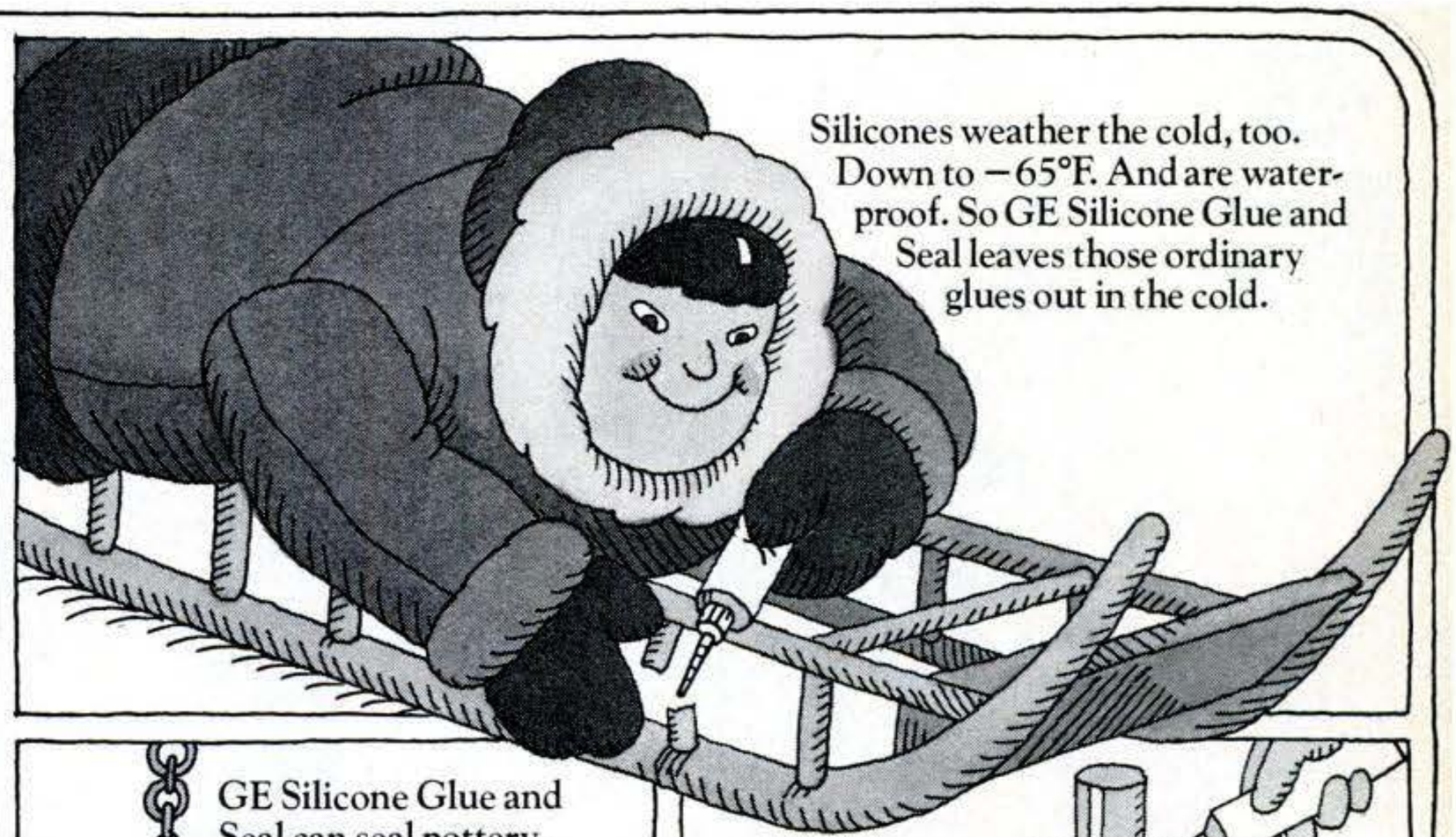
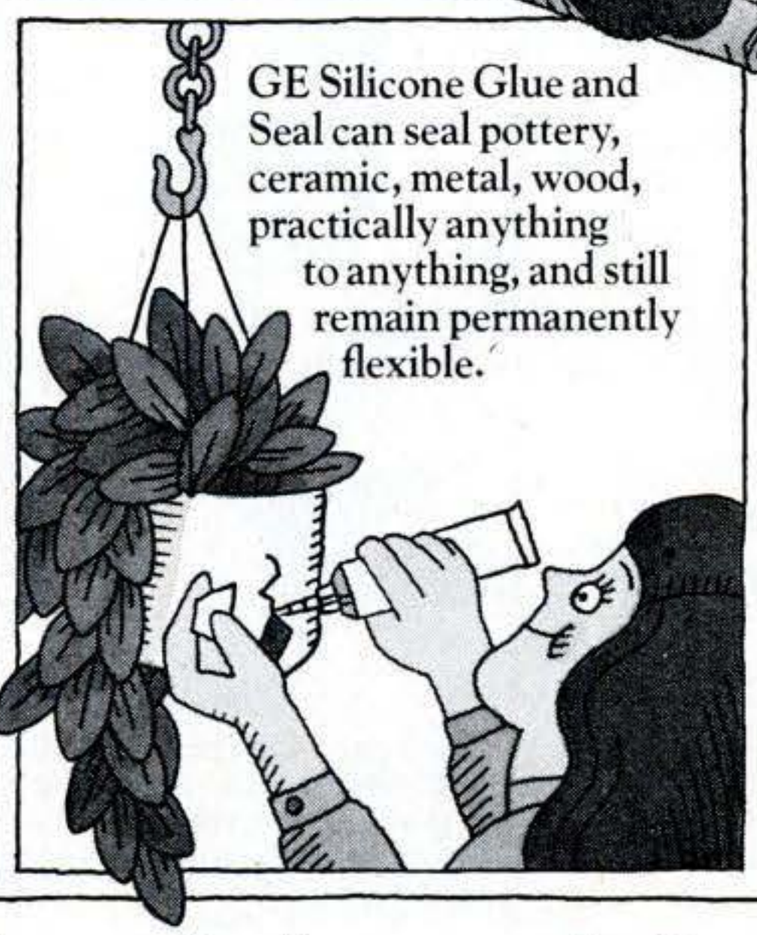
Silicone will glue and seal whatever needs gluing or sealing and do it better. So you glue it. Or seal it. And forget it. What's more, GE Silicone Glue and Seal and GE Silicone Bathtub Caulk and Seal won't crack, peel, fade, dry-out or discolor. To top it all off, now you get 1/3 more for your money while supplies last!

GE Silicone Bathtub Caulk and Seal is perfect to use anywhere in the bathroom because it's mildew resistant, waterproof and will withstand even the hottest showers (actually up to 500°F).



Silicones weather the cold, too. Down to −65°F. And are waterproof. So GE Silicone Glue and Seal leaves those ordinary glues out in the cold.



GE Silicone Glue and Seal can seal pottery, ceramic, metal, wood, practically anything to anything, and still remain permanently flexible.

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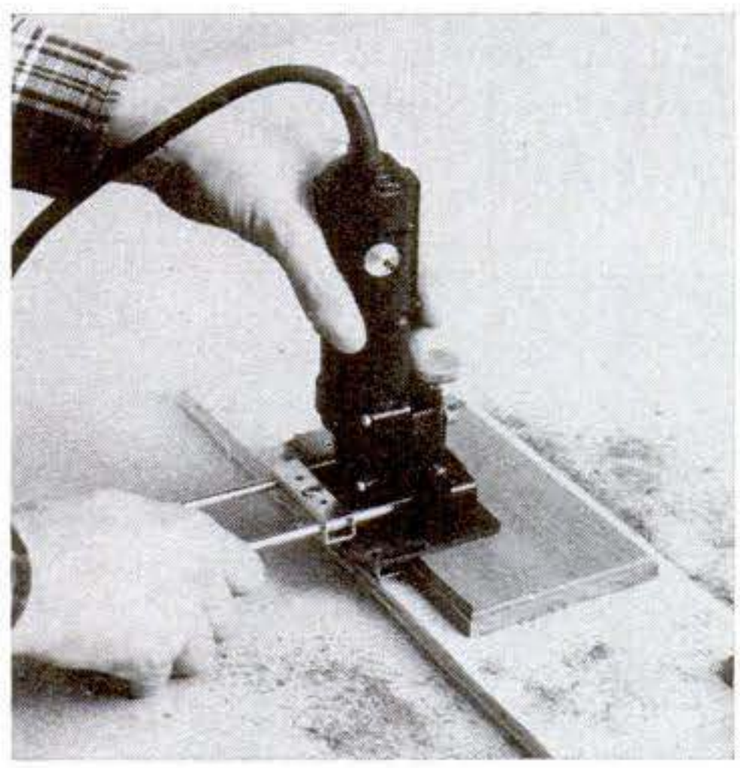
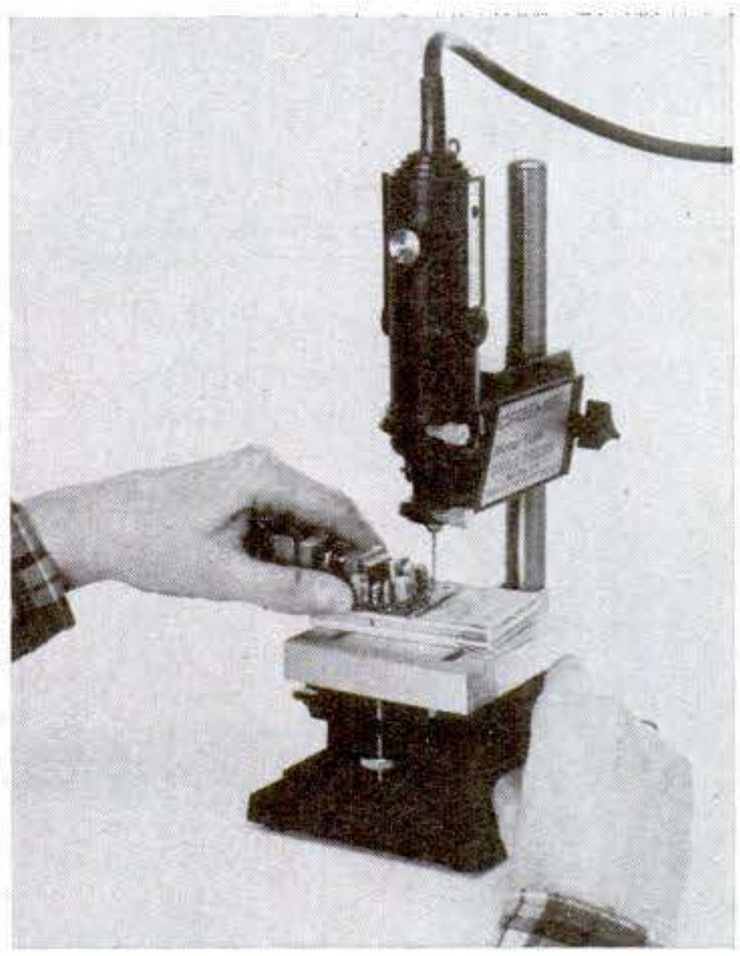
Steel, high-speed steel, and vanadium-steel cutters and burs are used for working wood, plastics (except glass-fiber reinforced types), plaster, and soft metals (such as die-cast). Price per cutter is about $2.

Tungsten-carbide cutters and burs are required for working harder materials such as hardened steel and fired ceramics—they should not be used for glass. Tungsten cutters and burs will outlast the best steel cutters many times. While they cost more initially ($4 to $5 each), they are more economical in the long run.

Carving drills taper to a point and cut along their entire flute length. They are made for internal carving of plastics and general drilling of soft materials. They can be moved sideways to hollow out cavities.

Hand-grinder attachments





Solid-state foot-speed controls: Dremel model 217 (top photo, left) works with most single-speed hand grinders and provides better speed control than "sewing-machine" controls; Foredom's control (right) is used with type-R motors. Dremel 229 router attachment (center photo) works best when gripped as shown. Dremel 210 drill-press attachment (directly above) keeps hand grinder stationary while table is cammed up for drilling. Adjustable stop is built into table.

Saws and brushes

Both steel and abrasive saws are used with hand grinders. Toothed steel saws are used for cutting thin sections of wood, plastics, and soft die-cast metal. Fine-toothed blades 0.005-inch thick are especially useful for slitting wood for model railroads and ships. Thin abrasive disks are used for slotting and cutting thin-walled tubing.

Brushes, usually furnished mounted on mandrels, come with natural or nylon bristles or steel or brass wire, and in three shapes—end, wheel, and cup. Bristle brushes are used for cleaning operations where the residue is soft, usually with a mild abrasive or polishing compound such as Bon-Ami or Noxon. Steel and brass wire brushes are used for removing rust, scale, and other products of oxidation, and for applying a decorative brushed finish to metal surfaces.

Polishing wheels can be made of cloth, felt, or rubber. The cloth wheels are simply layers of cotton cloth stitched into disks. Cloth and felt wheels are used with buffing-wheel compounds for polishing jewelry, metals, and plastics. Emery cake (black) is used where extra-heavy cutting is required, such as in removing rust. Tripoli (brown) is used for buffing aluminum, pewter, brass, copper, wood, bone, and plastic. Red rouge is used to produce a bright luster on gold, sterling silver, silver plate, and all soft or precious metals; and as a final polish on other materials after they've been buffed with other compounds. White rouge is used for stainless steel, cast brass, aluminum, chromium, nickel, and steel.

Rubber-bonded polishing wheels contain a fine abrasive (they can be compared to a good-quality typewriter eraser). They are made in points and wheels for mounting on mandrels, and can be shaped with a dressing stone to fit the job. They remove only a small amount of material, and can be used to produce an engine finish.—*Thomas H. Jones*

Hand grinder manufacturers/suppliers

Dremel Mfg. Div. (Emerson Electric Co.), 4915 21st St., Racine, WI 53406; **Foredom Electric Co.,** Bethel, CT 06801; **Handee (Chicago Wheel and Mfg. Co.),** 1101 W. Monroe St., Chicago, IL 60607; **Sears Roebuck** (catalog and retail stores); **Weller (Cooper Industries),** Box 728, Apex, NC 27502.

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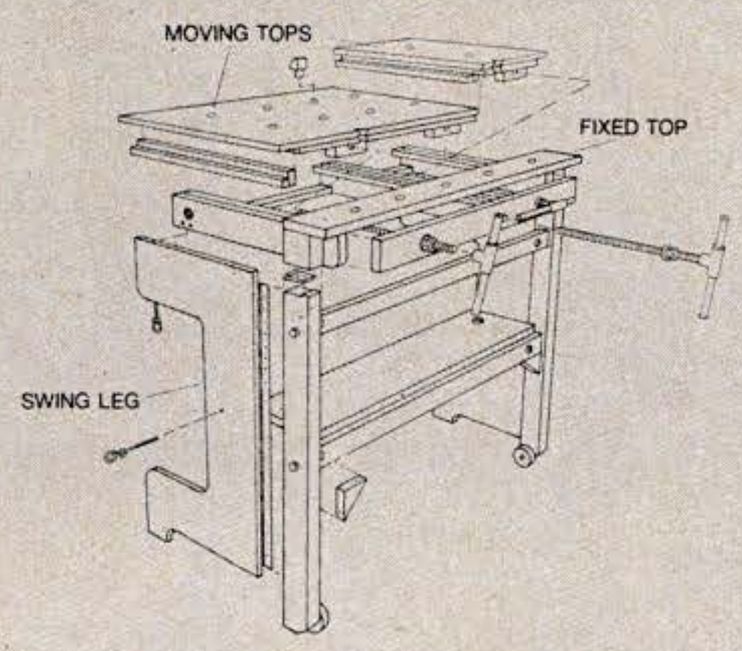
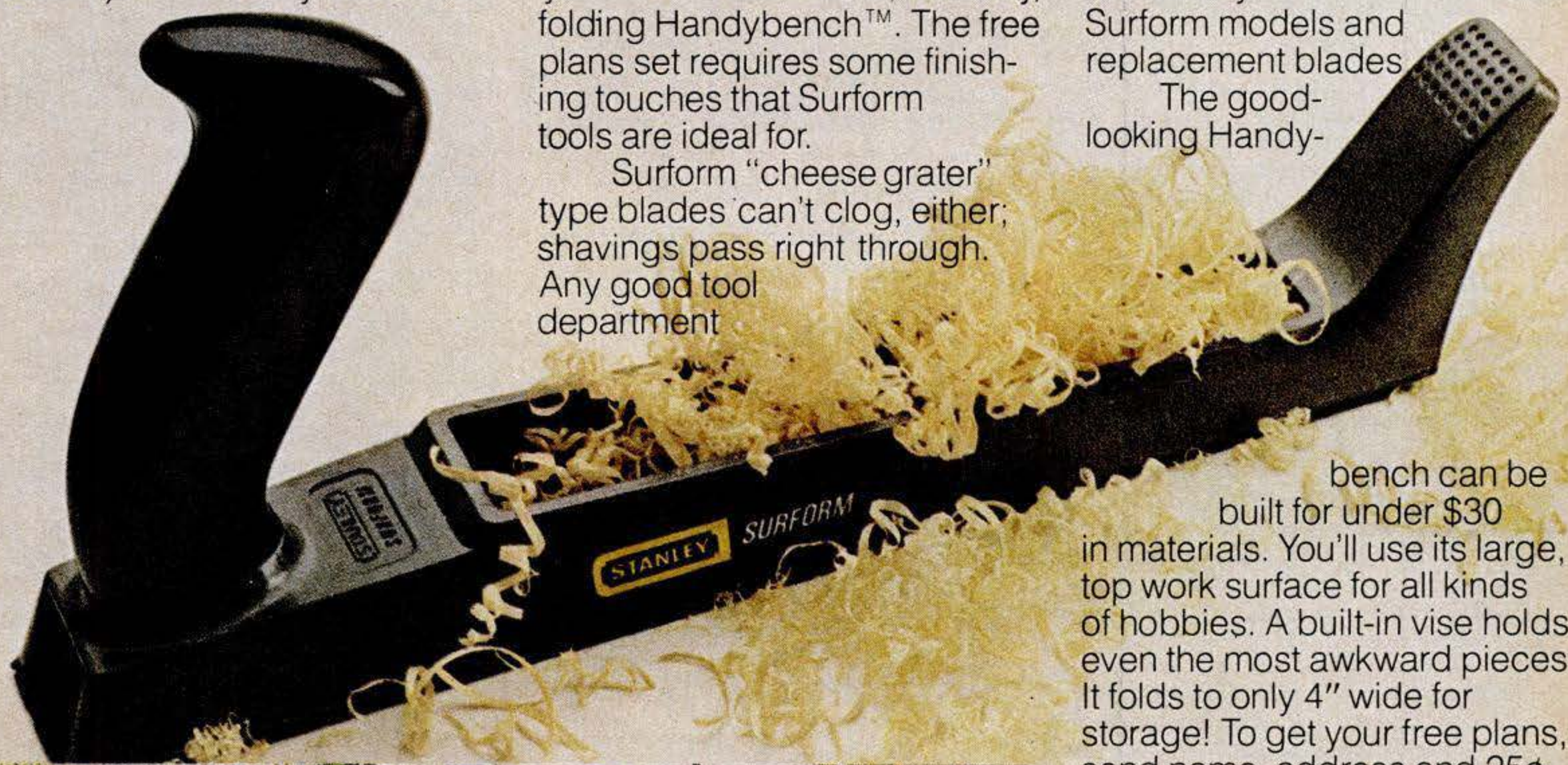


If you do any woodworking at all around your house, you own a saw, a hammer, a screwdriver. Just as important, and as basic, are Stanley Surform tools.

They're the easiest, simplest way yet to plane, file, form and smooth wood. (Or soft metals and laminates, for that matter.) Prove it for yourself as you build our versatile, rollaway, folding Handybench™. The free plans set requires some finishing touches that Surform tools are ideal for.

Surform "cheese grater" type blades can't clog, either; shavings pass right through. Any good tool department will show you several different Surform models and replacement blades.

The good-looking Handybench can be built for under $30 in materials. You'll use its large, top work surface for all kinds of hobbies. A built-in vise holds even the most awkward pieces. It folds to only 4″ wide for storage! To get your free plans, send name, address and 25¢ to cover postage and handling to Stanley Tools, Dept. SB, New Britain, CT 06050.



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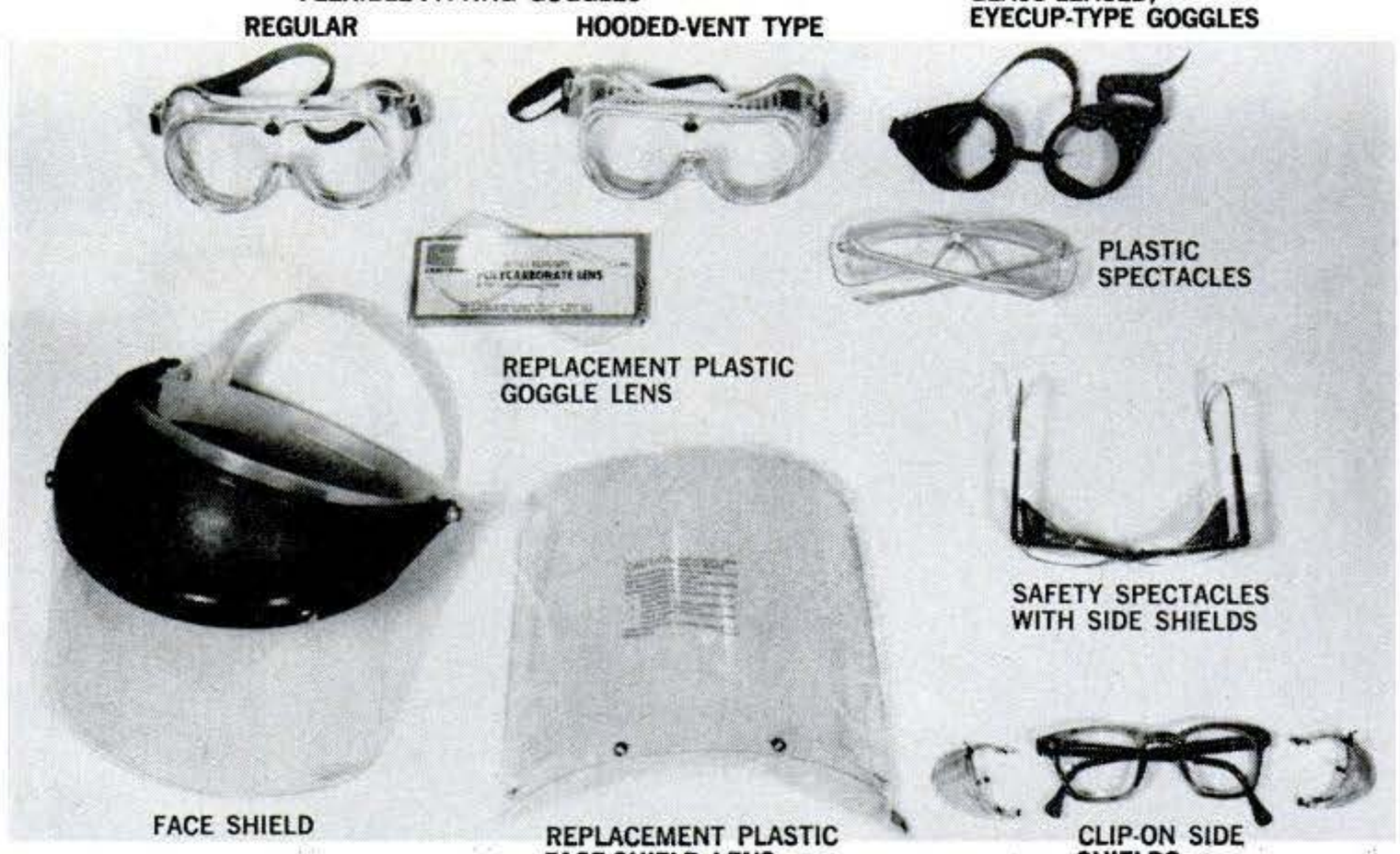
SPRING Home Value Ideas

Essential workshop insurance: eye/face protectors



You have only two eyes, of course, and replacements are hard to come by. That should be reason enough to protect your eyes whenever you use hand or power tools. And if there's any possibility of facial injuries, you should also use a face protector. Wearing these devices gives you an added benefit: You'll work better because you won't be flinching and squinting.

A pair of safety glasses is probably the best choice when you do hand-tool work, power woodworking and metalworking, chipping, light grinding, and similar jobs. *Not* "street" glasses with tempered glass lenses—these lenses are shatter-resistant but they are not safety spectacles.

The safety glasses you wear should be personally fitted, approved safety spectacles with glass lenses. Rims should fully surround the lenses. If you already wear glasses, the safety lenses can be ground to your prescription. (Of course, if you wear contact lenses, safety specs are a necessity.)

These safety glasses will withstand considerable impact—unless the lenses are scratched or pitted (such lenses should be replaced). When they do break, safety lenses tend to "spiderweb" and stay put within the rims.

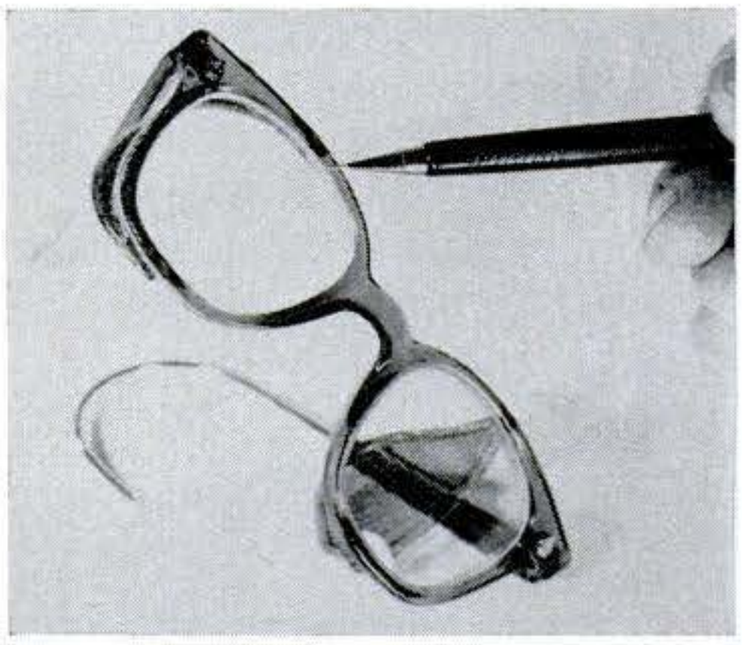
Safety specs with built-in shields offer protection from particles that might hit you from the side. Clip-on side shields are available, but the clip should have a mechanism that can't be easily dislodged with a blow. Should that happen, the shield itself could cause an eye injury.

Keep a pair of inexpensive plastic safety specs on hand, too, as "visitor" glasses. Everyone who wanders into your work area should also be protected.

Safety glasses are the most comfortable eye protectors for sustained wear, and the best bet for serious do-it-yourselfers. But the flexible-fitting plastic goggles shown in the top photo are also suitable for the jobs listed above. You can get goggles with hooded vents, which are useful when you work under extremely dusty conditions or when you handle chemicals.

If there's any chance that you may get hit in the face while working, wear a face shield. The chart above details the kind of protection needed for the jobs you may do.—*Mack Philips*

Avoid needless injuries: Wear eye protectors whenever you work with power or hand tools.



True safety specs will have the maker's mark on frames and lenses, and full lens rims.

Job	Hazards	Eye/Face protective equipment*
Gas welding, cutting, soldering, brazing	Sparks, molten metal, harmful rays	G with shade #2 lenses for soldering, welding, brazing; for light cutting, shade #3 or #4
Arc- or carbon-arc welding of steel	Same	H with shade #10 lens up to and including 5/32" electrodes. Shade #14 for carbon-arc welding. D under helmet desirable
Chemical and glass handling	Splash, burns, glass breakage	B with F
Chipping, paint scraping	Flying particles	A, B, C, D, or E
Power woodworking	Flying chips, dust	A, B, C, D, or E, with F to protect face when necessary
Grinding, power wire-brushing	Flying particles	A, B, C, D, or E. Add F for heavy grinding and wire-brushing
Power metalworking (machining)	Flying particles	A, B, C, D, or E
Hand-tool work	Flying particles	A, B, C, D, or E
Dusty operations	Dust particles	B
Visitors in work area	Flying particles	I

*Key: A—Flexible-fitting goggles
B—Hooded-vent flexible-fitting goggles
C—Rigid-body cushioned-fitting goggles
D—Safety spectacles with side shields
E—Eye-cup safety goggles
F—Face shield
G—Welding goggles
H—Welding helmet
I—Plastic "visitors" spectacles

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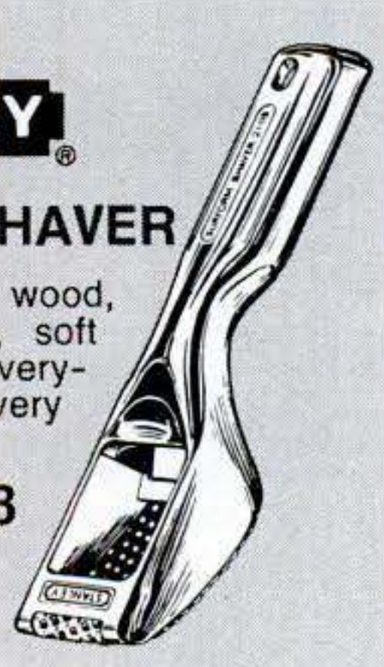

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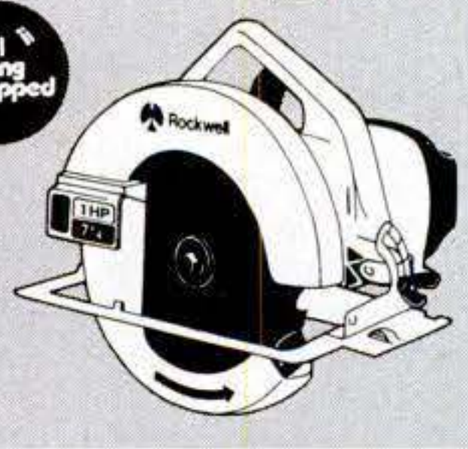

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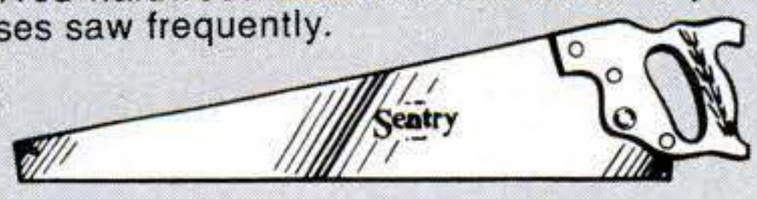

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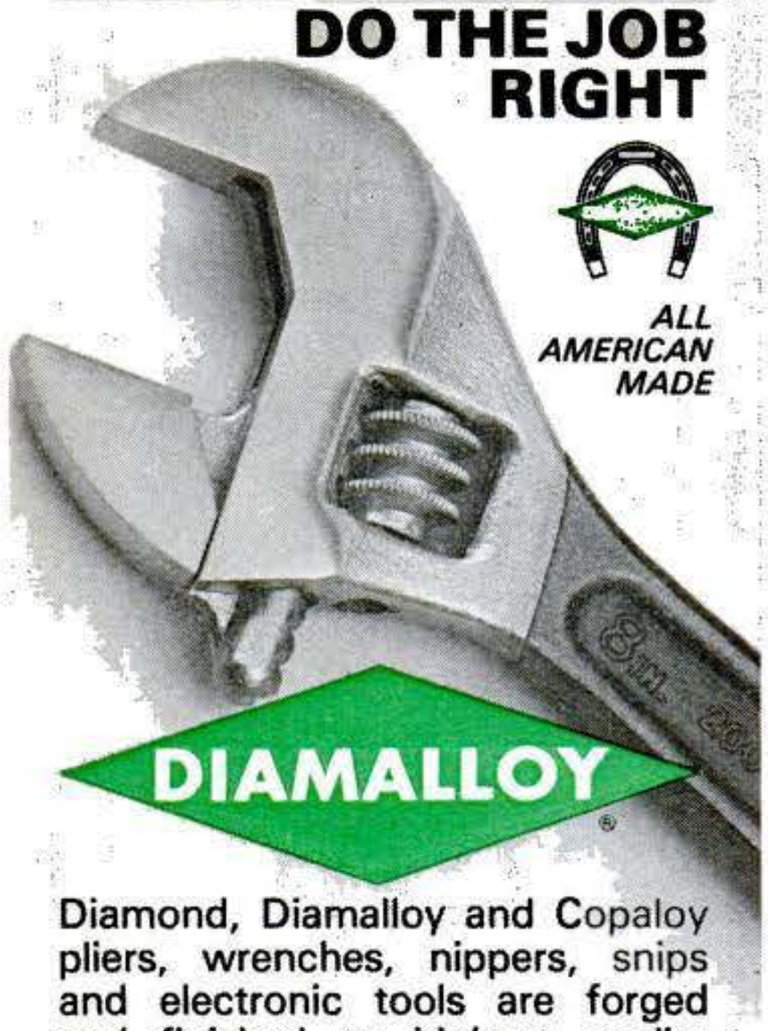

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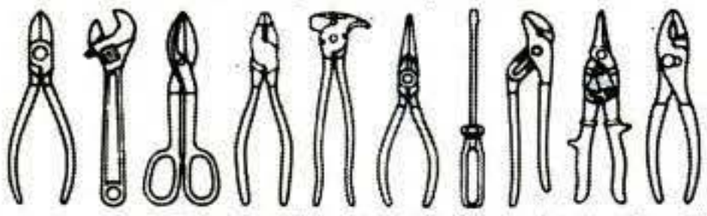

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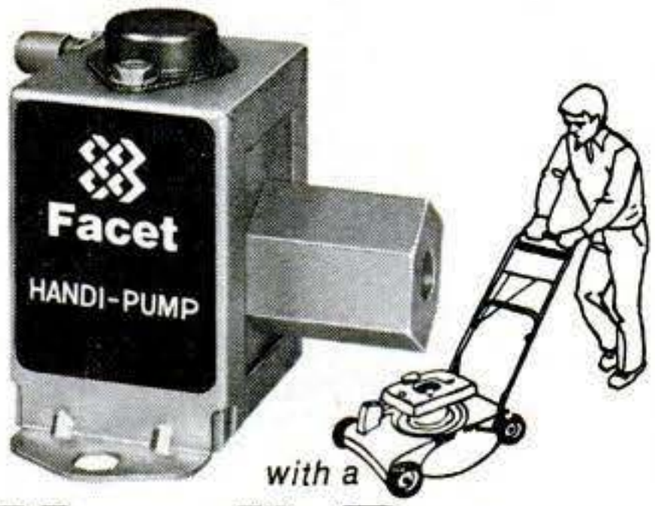

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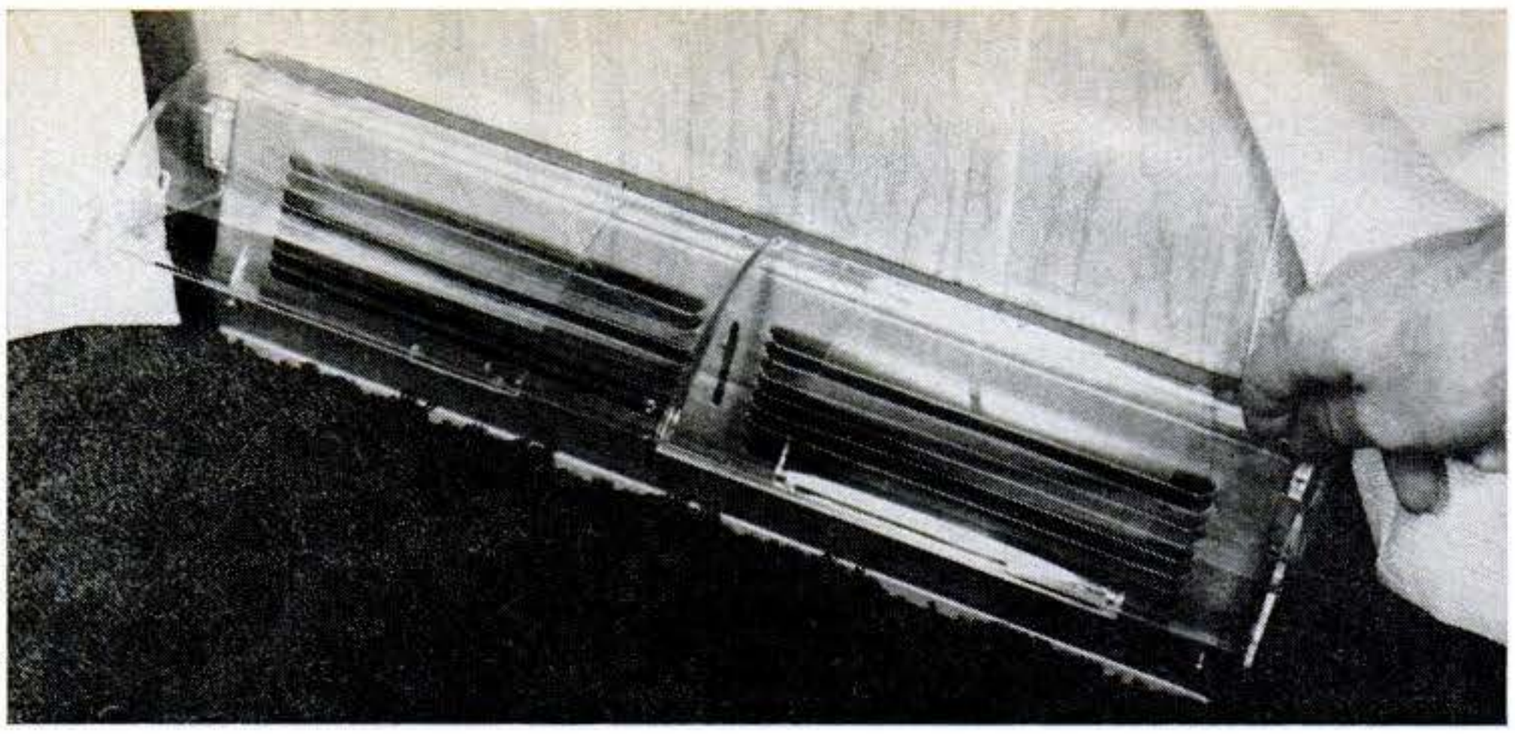

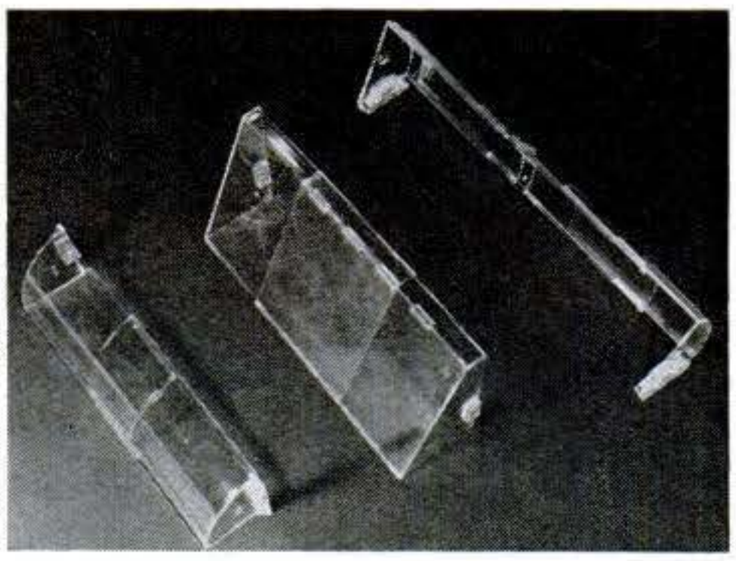

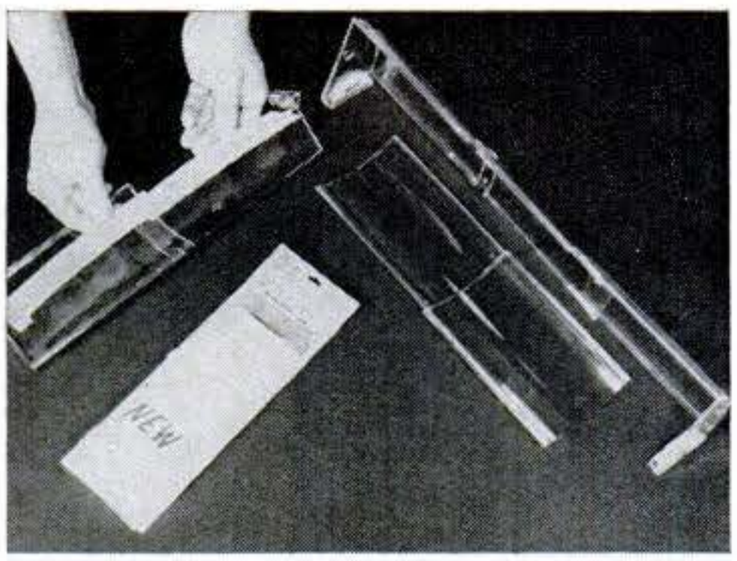

Heat the room, not your drapes. This unobtrusive deflector (top) directs air outward, keeping drapes cleaner and preventing them from billowing. Either arc- or wedge-shaped, deflectors come in several different styles (left). Most telescope to adjust to different register sizes. Replaceable air filters (right) make deflectors even more useful. And snap-in extensions (at far right) let you install them on longer baseboard registers.

SPRING Home Value Ideas

Air deflectors improve register efficiency

Want to direct the air from your registers to where it will do the most good—and save fuel in the bargain? Air deflectors are designed to do just that. As a bonus, many models also filter the air, making your home cleaner. And deflectors do all this quite cheaply—prices range from $2 to $6.

Made of clear plastic, deflectors are inconspicuous and easy to install. You simply attach them to metal registers with the tiny magnets provided. There are models to fit all standard-size registers, and you can get extensions to fit longer ones. Some deflectors come with dust filters; others are fitted to accept them, and replaceable filters are available.

These ingeniously simple devices are designed to counteract the tendency of warm air to rise and of cool air to fall. A deflector, attached to the top of a baseboard or low wall register, or installed at the rear of a floor register, will keep heat from rising straight up. Instead, it will direct the heat slightly outward, warming the room more evenly. That's how the fuel savings occur: When heat is evenly distributed throughout the room, you're not tempted to turn up the thermostat.

Install a deflector at the top of a high wall register, and you'll get the same results—the deflector will direct heat outward and downward to the living area. You can also fit a deflector over the top of a cold-air return to keep drapes from obstructing it.

For cooling comfort, simply reverse deflectors. Now they'll direct the air from a central air conditioner upward. The cool air will spread out at the ceiling, dispersing layers of warm air, and giving more uniform comfort at all levels. Deflectors perform the same job even if you're just using the furnace fan to circulate air in warm weather. And you can get specially designed deflectors that attach with strips of Velcro to window air conditioners.

One word of caution: Never use plastic deflectors on wall heaters, space heaters, or gravity furnaces. But deflectors fitted to the registers of your central forced-air system, your cabinet convectors, or your window air conditioners can make your home more comfortable—while requiring only minimal cost and effort on your part.—*Mack Philips*

WHERE TO GET THEM

Air deflectors are found at hardware stores and home centers, and at Sears and Wards. Maker/suppliers include: **Aristo-Mat Inc.,** 1718 E. 75th St., Chicago IL 60649; **Deflect-O-Corp.,** Box 50057, Indianapolis IN 46250; **Hold-All Mfg. Co., Inc.,** 3 Cross St., Suffern NY 10901; **Humidimatic Div.,** Hartley Prod. Co., 150 W. Summit St., Milford MI 48042; **Leigh Products,** Coopersville MI 49404.

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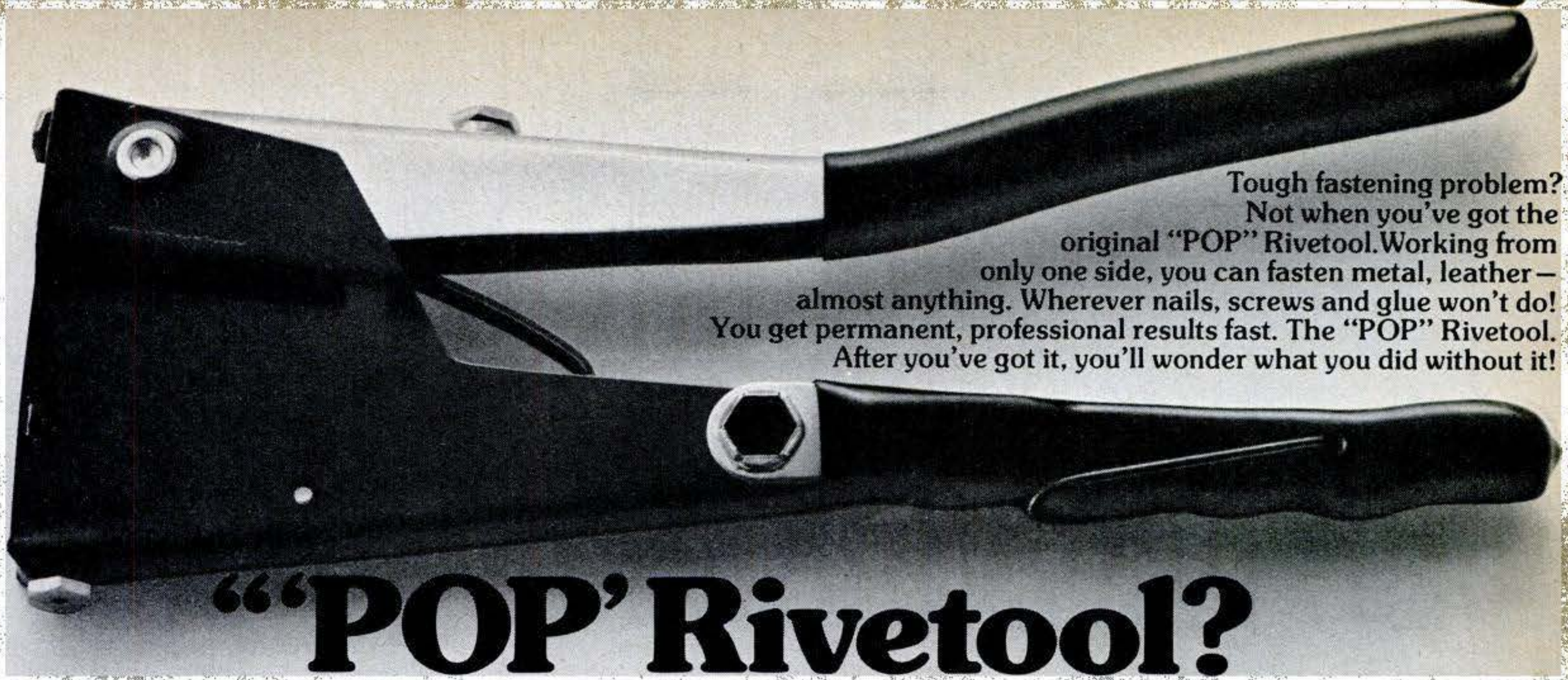
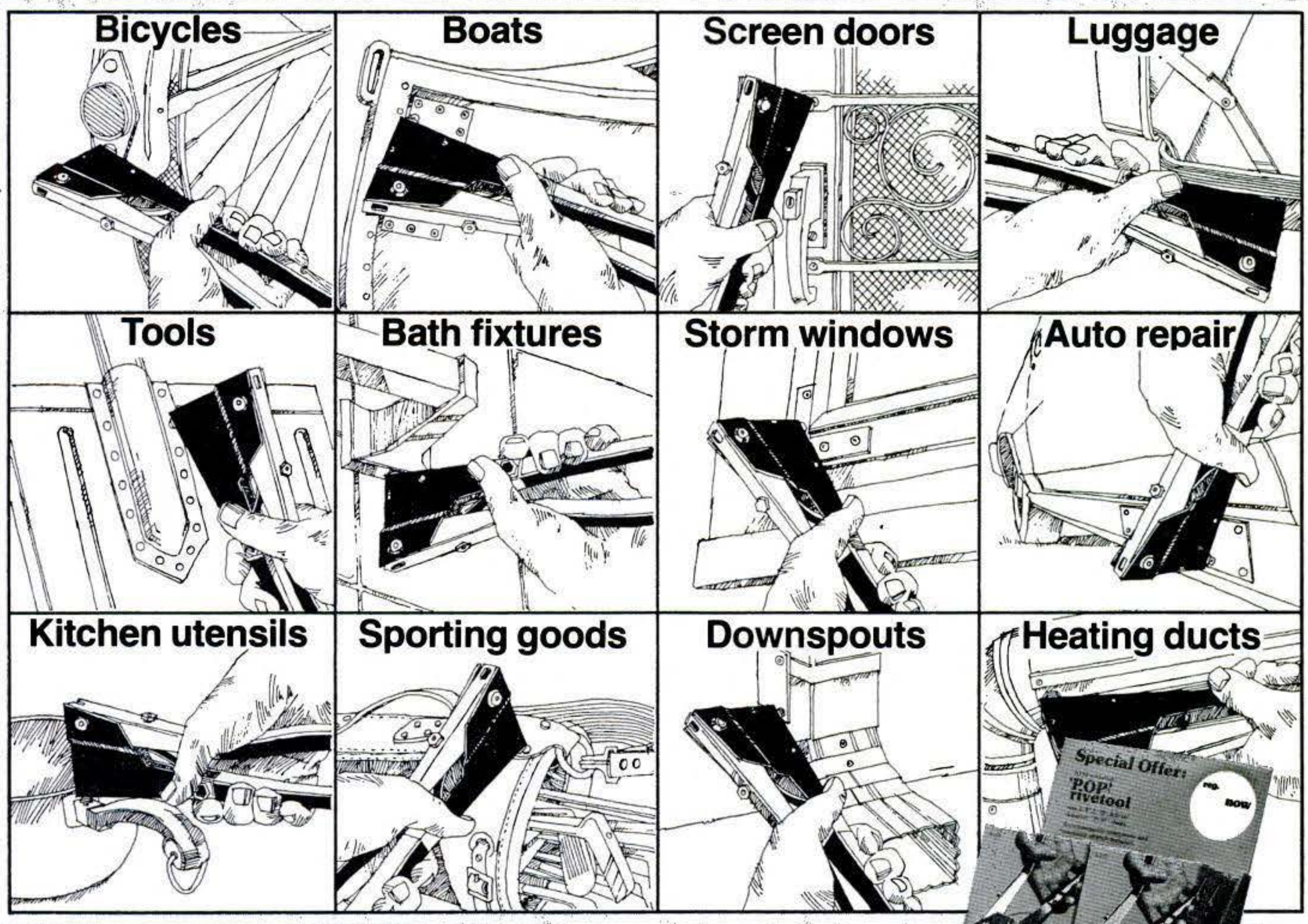


Tough fastening problem? Not when you've got the original "POP" Rivetool. Working from only one side, you can fasten metal, leather—almost anything. Wherever nails, screws and glue won't do! You get permanent, professional results fast. The "POP" Rivetool. After you've got it, you'll wonder what you did without it!

"'POP' Rivetool? What would I use it for?"



"How did I ever get along without it?"

Right now, there's a special on the "POP" Rivetool and separate Rivet Assortment. Look for this display.

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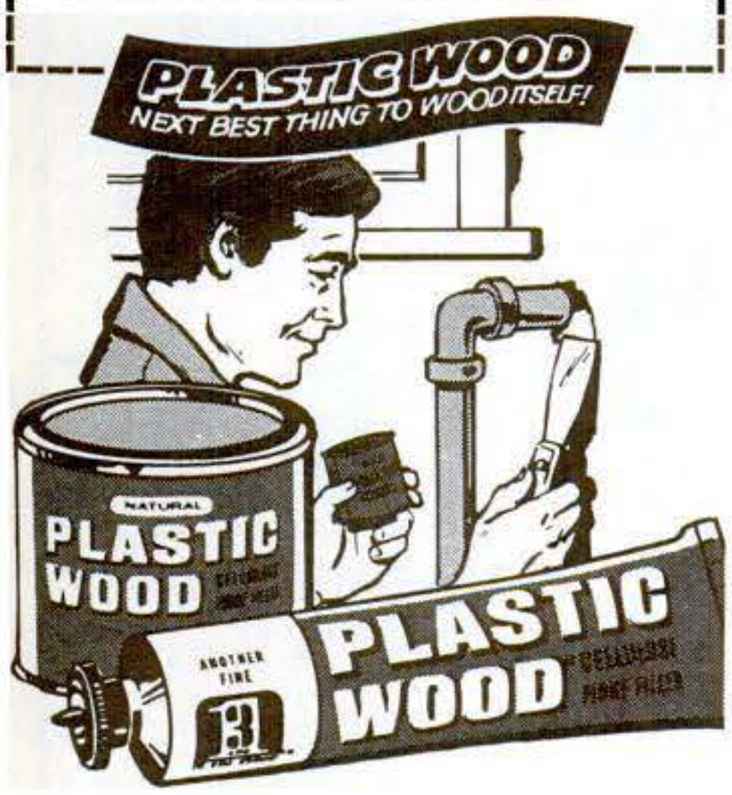
The DO-MORE CORNER

New ideas to help you do more with the products you have around the house.

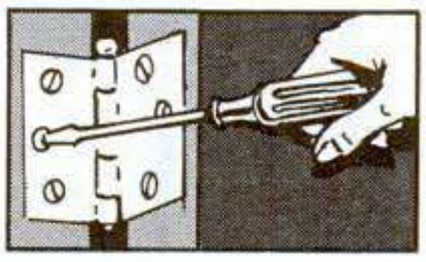


SEAL IT! USE GENUINE PLASTIC WOOD TO FILL IN AROUND WINDOWS AND PIPE HOLES TO KEEP OUT INSECTS, HEAT, DUST, RAIN, SNOW AND COLD AIR.

PLASTIC WOOD CAN HANDLE IT! FIX LOOSE HANDLES ON TOOLS, BRUSHES, MOPS, BROOMS, ETC PARTIALLY FILL SOCKET HOLE WITH RUGGED PLASTIC WOOD. INSERT HANDLE AND LET DRY FOR A LONG-LASTING REPAIR!

RELIABLE! YOU CAN COUNT ON RUGGED PLASTIC WOOD TO MAKE PERMANENT REPAIRS... EVEN ON FANCY SCROLL WORK. USE IT TO REBUILD DAMAGED AREAS ON ORNATE FURNITURE & PICTURE FRAMES.

PLIABLE! HOBBYISTS FIND VERSATILE PLASTIC WOOD'S PUTTY-LIKE CONSISTENCY IDEAL FOR MAKING WOODEN JEWELRY, COLLAGES AND WOOD SCULPTURES... BUILDING MODEL RAILROADS PLANES & SHIPS



DON'T FORGET THE ONE AND ONLY PLASTIC WOOD FOR EVERYDAY REPAIR OF CRACKS, HOLES & SPLINTERS IN BASEBOARDS, HARDWOOD FLOORS, DOORS, SHELVES AND RAILINGS. IT'S GREAT FOR RESETTING LOOSE SCREWS, HINGES AND LATCHES, TOO. TRY IT!

VISIT YOUR HANDY HARDWARE HOME CENTER NOW AND SAVE

SPRING Home Value Ideas

Troubleshoot your garden tractor after a season's disuse

If your garden tractor won't start after sitting in the garage all winter, you may be able to locate and repair the trouble—and save yourself time and money—even if you're a relatively inexperienced mechanic. The key to solving starting problems is systematic troubleshooting—the method used by experienced auto mechanics. By checking the fuel and electrical systems systematically, you can track down the problem by elimination.

Every spark-ignition engine requires (1) fuel and air supply to the combustion chamber, (2) a spark to ignite the fuel mixture, and (3) adequate compression.

Start your check by making sure there is gas in the tank. It may seem obvious, but more than one professional mechanic has checked over an engine thoroughly only to discover that the problem was lack of fuel. While you're at it, check the oil level in the crankcase too.

Next, note the cranking speed of the electric starter. If it's slow, have the battery tested and clean the battery posts and cable terminals with a wire brush. If there's no improvement, the problem is in the starter and the tractor goes to a repairman.

If the motor is cranking adequately, then begin your check with the ignition system. Remove the spark plug and check its appearance. If the electrodes at the firing end are burned or if the porcelain insulator is cracked, replace the plug. Check the electrode gap; it should be 0.025 inch—about the thickness of a dime. (An auto-parts store can sell you a plug-gapper for about two dollars.) Before reinstalling the plug, bend the outer electrode away from the center electrode to produce a gap of about 1/8 inch. Connect the spark-plug wire to the plug, making sure the wire is firmly attached at both ends.

Lay the plug flat on the metal engine block, crank the engine, and watch the plug. If you see a fat, blue spark jump the gap, your ignition system is working properly. If there is a very weak spark or none at all, something is wrong in the points, condenser, or coil. If you don't have experience in this area, it's a good idea to seek professional help.

But if you got a good spark, it's time to check the fuel system. Squirt a spoonful of gas into the spark-plug hole and reinstall plug (0.025 gap). If the engine starts momentarily, but dies, fuel is not reaching the combustion chamber. To check if fuel is reaching the carburetor, remove the line that runs from the fuel tank to the carburetor at the carburetor side. Fuel should flow out steadily. If it doesn't, find the blockage and remove it. If there's full flow, the problem may be with the carburetor: The motor may be getting fuel but not air. To check, remove the air cleaner and crank the engine. If it starts, the problem is a clogged air cleaner, so replace it. (Be sure not to run the engine for a long period with the air cleaner removed; dirt intake could cause damage.) If it doesn't start now, try draining the tank and refilling with fresh gas (gasoline goes stale during storage if a gas stabilizer has not been added). If it still hasn't started the problem is either the carburetor operation or a lack of compression and you should take it to a repair shop.
—Rich Ceppos

Check fuel supply. Massey-Ferguson suggests buying no more than a 30-day supply, since fresh gas and the right blend for the season make starting easier.

Dirty air cleaner can cut your tractor's power and economy. Check it routinely for clogging at the beginning of each season. (Photos courtesy of Massey-Ferguson, Inc.)

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We're Champion Building Products. And we want you to know more about paneling.

Whether it's our own famous Weldwood® paneling—or anybody else's for that matter.

Weldwood Collection
Charter Pecan

We want you to know how important it is to pick the right panel for the right room and decor. (Notice how the hardwood beauty of our Charter Pecan™ paneling works with the lighting, artwork and accessories to achieve something unique in this picture.)

We want you to know that some paneling is faced with real wood, and others with not-so-real wood. (Weldwood comes in a complete range of authentic hardwood veneers, or amazingly faithful simulated woodgrains. With a veritable forest of styles, textures and prices to choose from.)

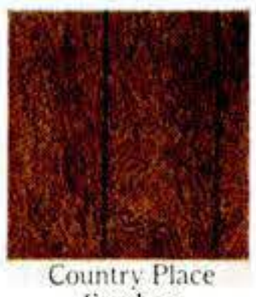
We want you to know that good paneling provides long-lasting beauty with a minimum of care.

We make Weldwood paneling. And we make all kinds of other building products like lumber, sheathing and Weldwood® sidings. You can find them all at your Headquarters/Champion Building Products Dealer (formerly U.S. Plywood). He's listed in the Yellow Pages under "Paneling."

And if you'd like to know more about the paneling, send for our full-color booklet, "All About Wall Paneling." It's filled with decorating hints, and it's yours when you send your name, address and 50¢ to Champion Building Products, Box 61, N.Y., N.Y. 10046.

Centennial 2
Riverview Hickory

Craftsman
Gloaming Hickory



Country Place
Smokey

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The DO-MORE CORNER

New ideas to help you do more with the products you have around the house.

WINDOW MOVER! STICKY WINDOWS SLIDE EASIER IF YOU PUT A FEW DROPS OF 3-IN-ONE HOUSEHOLD OIL ON THE RUNNERS. GREAT FOR SLIDING DOORS, TOO.

TAR REMOVER! VERSATILE 3-IN-ONE HOUSEHOLD OIL ON A RAG DISSOLVES ROAD TAR FROM CAR BUMPERS, FENDERS & ROCKER PANELS. WON'T HARM PAINT OR CHROME

APPLY IT! NEXT TIME YOU USE A SAW, WIPE 3-IN-ONE HOUSEHOLD OIL ON THE BLADE. YOU'LL BE AMAZED HOW IT MAKES SAWING EASIER, FASTER.

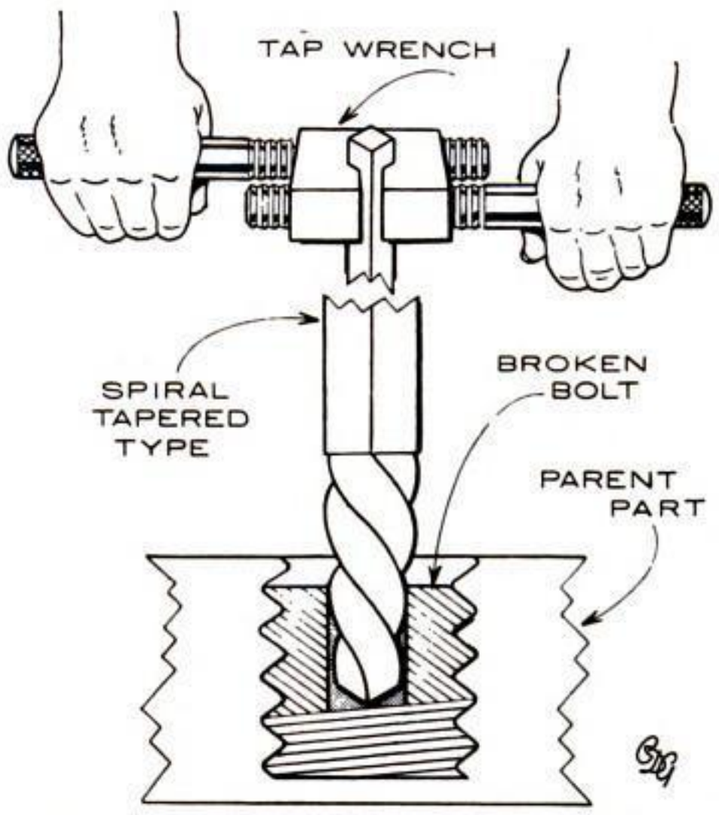
TRY IT! TRY PUTTING A DROP OF 3-IN-ONE HOUSEHOLD OIL ON SCREWS AND NAILS. THEY GO INTO WOOD A LOT EASIER.

BUY IT! GET A CAN FOR YOUR BICYCLE. 3-IN-ONE HOUSEHOLD OIL ON WHEEL AND PEDAL BEARINGS, SPROCKETS AND CHAIN MAKES PEDALING EASIER.

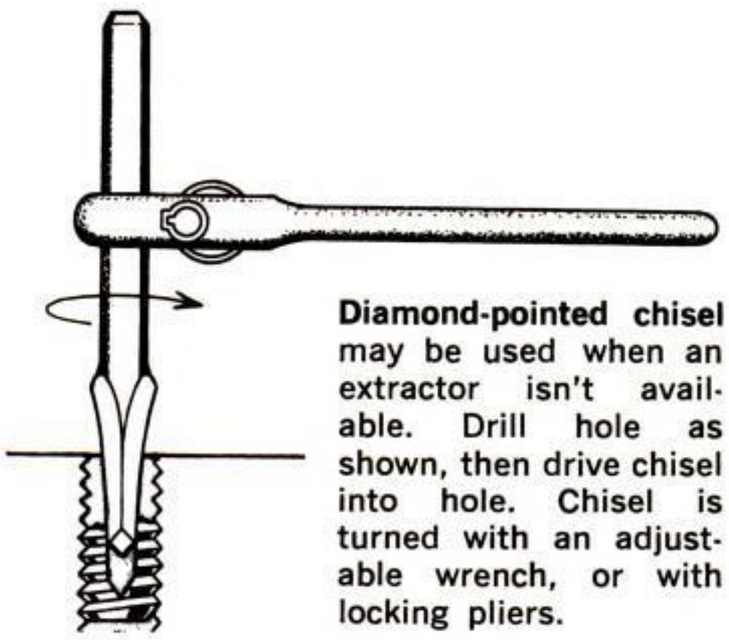
VISIT YOUR HANDY HARDWARE HOME CENTER NOW AND SAVE

SPRING Home Value Ideas

Removing broken bolts, studs, and screws



Bolt extractor is placed into hole drilled in center of broken bolt or stud. Tap wrench is used to turn extractor counterclockwise to withdraw the broken threaded shaft.



Diamond-pointed chisel may be used when an extractor isn't available. Drill hole as shown, then drive chisel into hole. Chisel is turned with an adjustable wrench, or with locking pliers.

Drill sizes for extractors

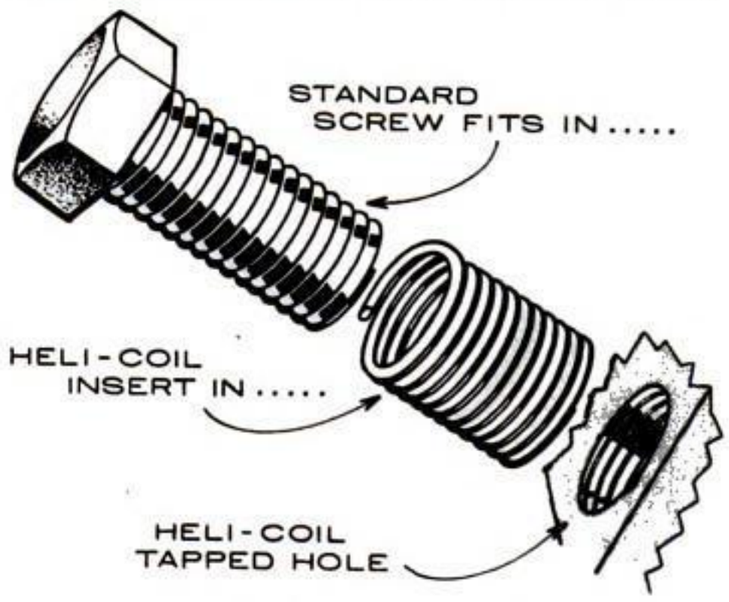
Extractor no.	Drill size	For screw size
1	5/64"	#10-1/4"
2	7/64"	1/4"-5/16"
3	5/32"	5/16"-7/16"
4	1/4"	7/16"-9/16"
5	17/64"	9/16"-3/4" & 1/8"-1/4" pipe
6	13/32"	3/4"-1" & 3/8" pipe

Removing broken studs and bolts is one of the most frustrating problems facing the home craftsman or weekend mechanic. By following these procedures and working with simple tools available at hardware and auto-supply stores, you'll not only make fast work of such removal, but you'll save the expense of having a machinist do the job for you.

The first thing to do is check the size of the broken stud or bolt: Use a rule, slide caliper, or micrometer to measure its outside diameter. If it's broken below the surface, you can use a tap to check the hole. If it's broken off above the hole, you can use a die to check the broken-off portion. Sometimes a broken bolt or stud is part of a series (as with a manifold). If so, simply measure one of the other bolts or studs. When you've determined the size of the bolt or stud, refer to the chart to select the proper drill and screw extractor.

Next, center-punch the bolt or stud, making sure the punch mark is on center so your drill will start correctly. Drilling the hole on center reduces the torque necessary to turn the extractor.

When drilling the hole, make sure it's deep enough for the extractor to get a good grip. If you cannot drill that deeply, you can vary the depth at which the extractor will grip by changing the diameter of the drill. (A smaller drill will cause the extractor to grip closer to the point.) Once the hole is drilled to the correct depth, insert the extractor and tap it lightly



Heli-Coil insert allows you to drill out broken stud. Hole is drilled to oversize, then tapped. The insert is screwed into hole, and a fresh stud is screwed into these new threads.

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with a hammer. Place a tap wrench on the extractor and turn it counterclockwise. If space won't permit the use of a tap wrench, use an adjustable or open-end wrench. But a tap wrench gives you better control. Be careful not to use too much pressure: Screw extractors are made of hardened tool steel—they are very hard, but very brittle. Any sudden jar or excessive twisting can break the extractor and compound your problem.

If all else fails there's a relatively inexpensive kit you can buy that can solve your problem—the Heli-Coil kit. Basically what you do is drill the stud or bolt out of the hole and drill the hole a little bigger than it originally was. Then you tap the oversize hole with a special tap and screw the Heli-Coil insert into the hole with another tool (all provided in the kit). Finally, you screw the original bolt or stud into the Heli-Coil insert (see drawing). Full instructions come with the kit.

TAP DRILL SIZES

SCREW SIZE	TAP DRILL	SCREW SIZE	TAP DRILL	SCREW SIZE	TAP DRILL
6-32 NC	#36	12-24 NC	#16	3/8-16 NC	5/16
-40 NF	#33	-28 NF	#14	-24 NF	Q
8-32 NC	#29	1/4-20 NC	#7	7/16-14 NC	U
-36 NF	#29	-28 NF	#3	-20 NF	25/64
10-24 NC	#25	5/16-18 NC	F	1/2-13 NC	27/64
-32 NF	#21	-24 NF	I	-20 NF	29/64

Another problem you might encounter is a screw that's stripped, or one whose slot is badly mutilated. In such cases, usually it is easier to remove the head of the screw. Use a small rotary file or mounted grinding wheel to carefully remove the edges of the slot so your drill will have a place to start. Otherwise you stand a good chance of breaking your drill bit if the cutting lips catch in the slot or recess.

Follow the drilling procedure already explained: Select a drill for the extractor you want to use, and drill a hole in the center of the screw, about 1/8" deeper than the head thickness; now, redrill with a bit the same diameter or slightly larger than the body of the screw. If you've drilled the hole on center, the head should pop off as soon as you reach the body of the screw. If the screw is completely stripped, it may spin when you try to drill it. To stop this, simply wedge the screw, or place something between the pieces the screw is holding.

After removing whatever the screw was holding, check to see if the screw is loose. Often a screw may seem very tight; however, when the head is removed, so is the pressure, and the remaining part of the screw can be taken out by hand. If you must use an extractor, the lead hole should still be visible; all you will have to do is make it deeper and insert your extractor.

If you accidentally break an extractor and can't remove it with pliers, heat it with an oxyacetylene or propane torch until it's cherry red. Let it cool and reheat it. Doing this several times will soften it enough so it can be drilled out.—*Edward Hoffman*

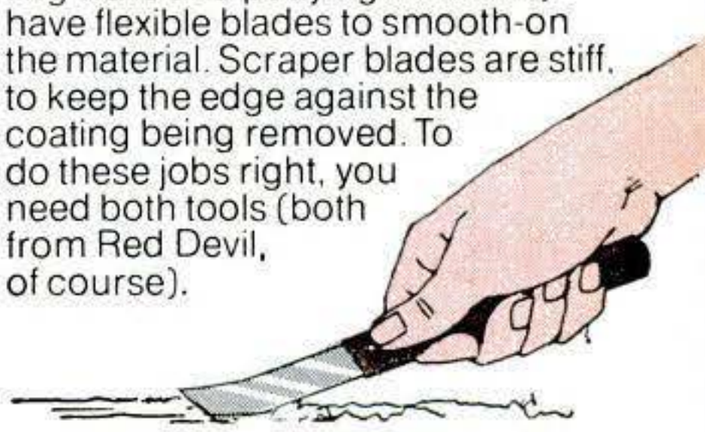
HANDY IDEAS FROM BIG RED T.M.

A handy man to have around the house.

More home fix-up tips from the pro.

Fill the tub before you caulk. (Get in if you can, too.) Then, when the tub is empty, it'll rise slightly and squeeze the caulk. Even a good flexible caulk (like Red Devil's) will serve you longer when the filled weight is not stretching it between the tub and wall.

A putty knife is not a scraper. And vice versa. Putty knives (for spackling walls and puttying windows) have flexible blades to smooth-on the material. Scraper blades are stiff, to keep the edge against the coating being removed. To do these jobs right, you need both tools (both from Red Devil, of course).

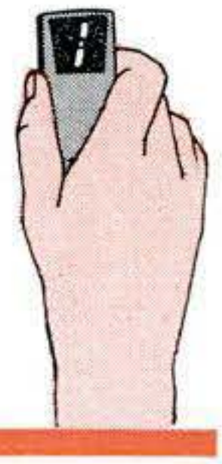


Caulk is caulk is caulk? Wrong! Latex or acrylic latex caulk provide excellent durability (especially when painted) and easy clean-up for most uses, but you'll need butyl caulk for the water resistance required at or below ground level. Different caulks for different jobs, that's why Red Devil offers different kinds.

Bag your paint brush. Don't throw away the plastic cover when you buy a new paint brush. It'll keep the brush dust-free and in perfect shape between uses. Red Devil brushes come with re-sealable covers for just that reason.

Bargain paint rollers can cost you more. Those cheap one-piece roller and cover combinations often don't put enough paint on the wall or put it on unevenly. The results? You'll have to buy more paint to apply an extra coat. Better roller covers (like Red Devil's) will help you get the most "mileage" out of your paint.

Stud finders are un-holey. When hanging pictures on a freshly painted or papered wall, don't fill it with holes before you find the wood behind it. Use a Red Devil Stud Finder. It points out where nails are—and where there are nails, there are studs.



Red Devil has hundreds of things to make your home fix-up easier. Look for them wherever you shop for home-care products. And for best results, always follow directions on the package.

Red Devil®

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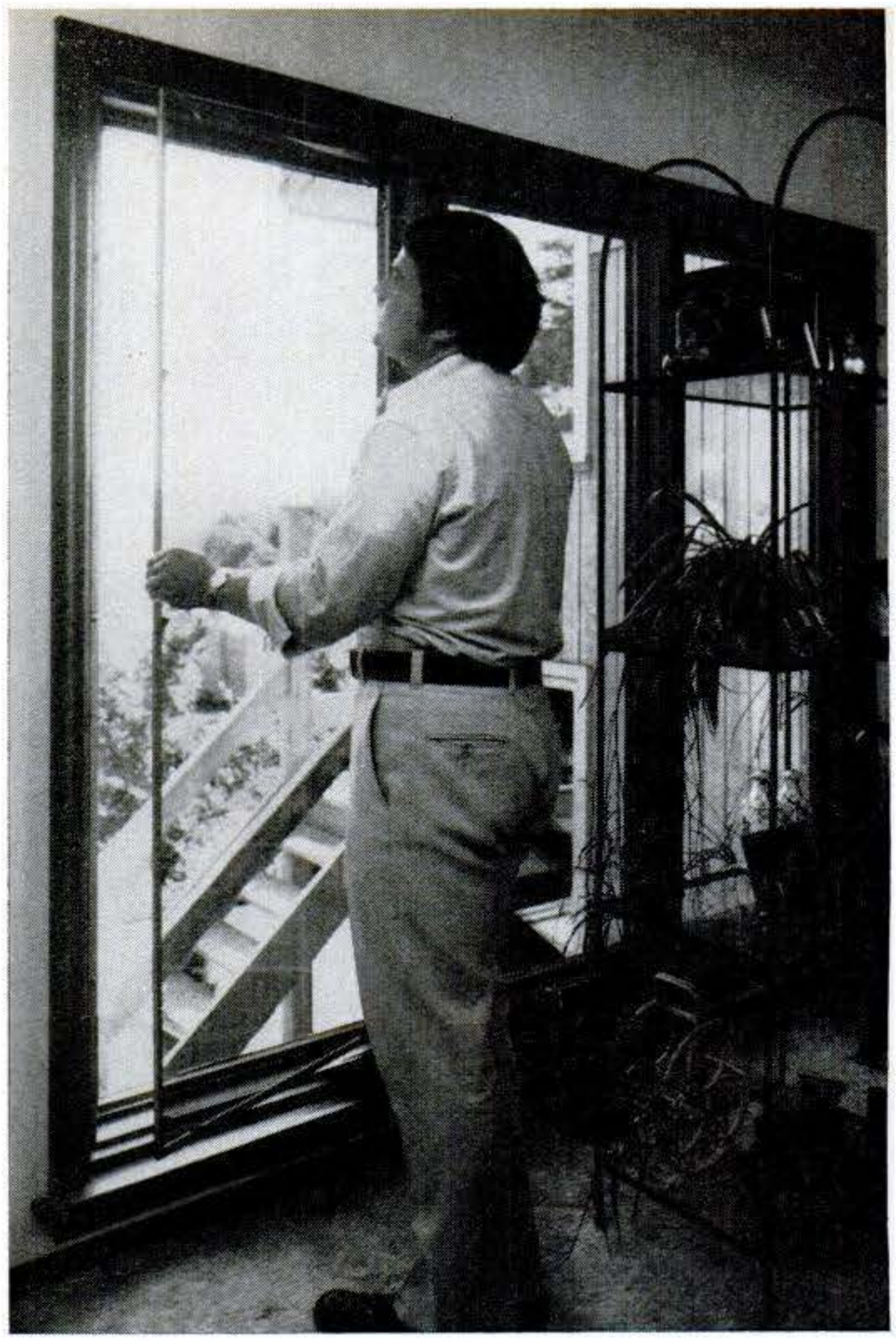
SPRING
Home Value Ideas

Solar-ban film and glass keeps your home or RV cool

In summer, PPG Solarcool glass is installed in southern and western exposures to reduce solar heat gain. Installed outdoors, it cuts heat gain by 56 percent; indoors (right), by 34 percent. In winter, replace with clear glass.

Even with a peel-off backing, Reflecto-shield requires water spray on its adhesive before application, like other films. Most films appear dimpled and hazy for a few days, until fully bonded.



My RV's fading upholstery and overworked air conditioner prompted me to look for a way to reduce solar heat buildup and ultraviolet penetration in the interior. The answer was sun-control film [PS, Sept. '74]. It is the silvery material that you sometimes see on the windows of homes and vans such as Ray Hill's [PS, March]. It does an admirable job of rejecting solar heat and reducing ultraviolet penetration. (UV is the portion of the light spectrum that causes about 85 percent of fading.)

There's a wider choice of materials since our first report: The 3M Company is producing new versions of Scotchtint film. In addition to the old silver-blue material, the company nows offers gold, smoke, and bronze. All have a metallic layer coated onto the base film by a chemical vapor deposition process. Reflecto-Shield film by Madico is available in gold, silver, and bronze. Metallized Products' Sun/Gard line now contains silver, gold, gray, and bronze films.

These new films are applied much like those we've already reported on—but there are some changes. The Scotchtint no longer has a backing sheet; it uses a water-activated "detackified" adhesive instead. When you're ready to apply it, spray the window and the back of the film with a light water mist. A pump sprayer from an old bottle of window cleaner works well—if you flush it clean before using it.

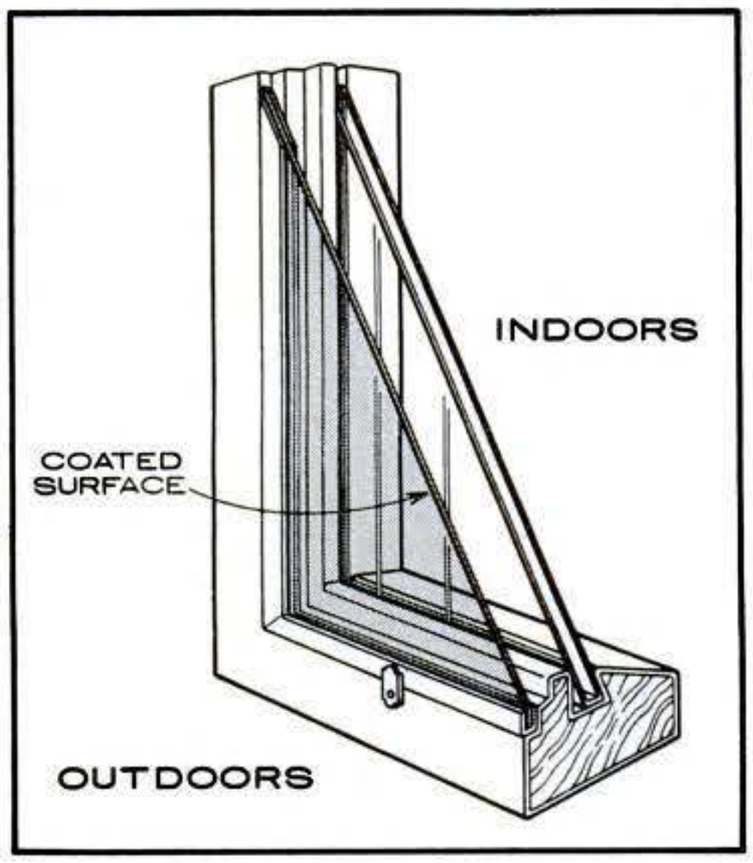
The Reflecto-Shield differs from the Scotch film in that it has a clear plastic backing over the adhesive coating.

With the film installed on my RV (I chose the bronze Scotchtint), colors aren't at all distorted. I found a noticeable improvement in the air conditioner's capabilities, and temperatures were much more consistent throughout the camper. All of these new films have an ultraviolet-transmission rating of zero, which should practically eliminate fading problems. They also reduce glare, provide increased shatter-resistance, and eliminate almost 80 percent of the heat penetration from solar radiation.

Be sure to check state laws before installing a sun-control film in any motor vehicle, and never apply it to the front side windows or windshield, where you need maximum visibility.

Though sun-control film will reduce desirable solar input in the winter, the metallic film also reflects some interior heat back into the room that might otherwise escape through the windows, so it's not a total loss in cold weather.

A new product that can solve even this problem is PPG Solarcool bronze reflective glass. These panels are made with a process that firebonds a durable, light- and heat-reflective metallic oxide coating to the tinted base glass. They're available (in 1/8- and 3/16-inch thicknesses) in a number of stock sizes. The big advantage of the glass panels is that they can be installed like storm windows or used as double-glazing panels in patio doors.



Solarcool bronze reflective glass panels can be installed like storm windows or glazed into an auminum or wood sash.

Under development in the lab (but likely far down the road) are strippable films that can be placed on the window in summer, peeled off and stored for winter, and then replaced in late spring; and "invisible" films with little or no tinting.—*Evan Powell*

WHERE TO WRITE FOR MORE INFORMATION:
3M Company (Scotchtint), 3M Center, St. Paul MN 55101; **Madico** (Reflecto-Shield), 64 Industrial Parkway, Woburn MA 01801; **Metallized Products, Inc.** (Sun/Gard), 2647 24th St. North, St. Petersburg FL 33713; **PPG Industries** (Solarcool), 10 North, One Gateway Center, Pittsburgh PA 15222.

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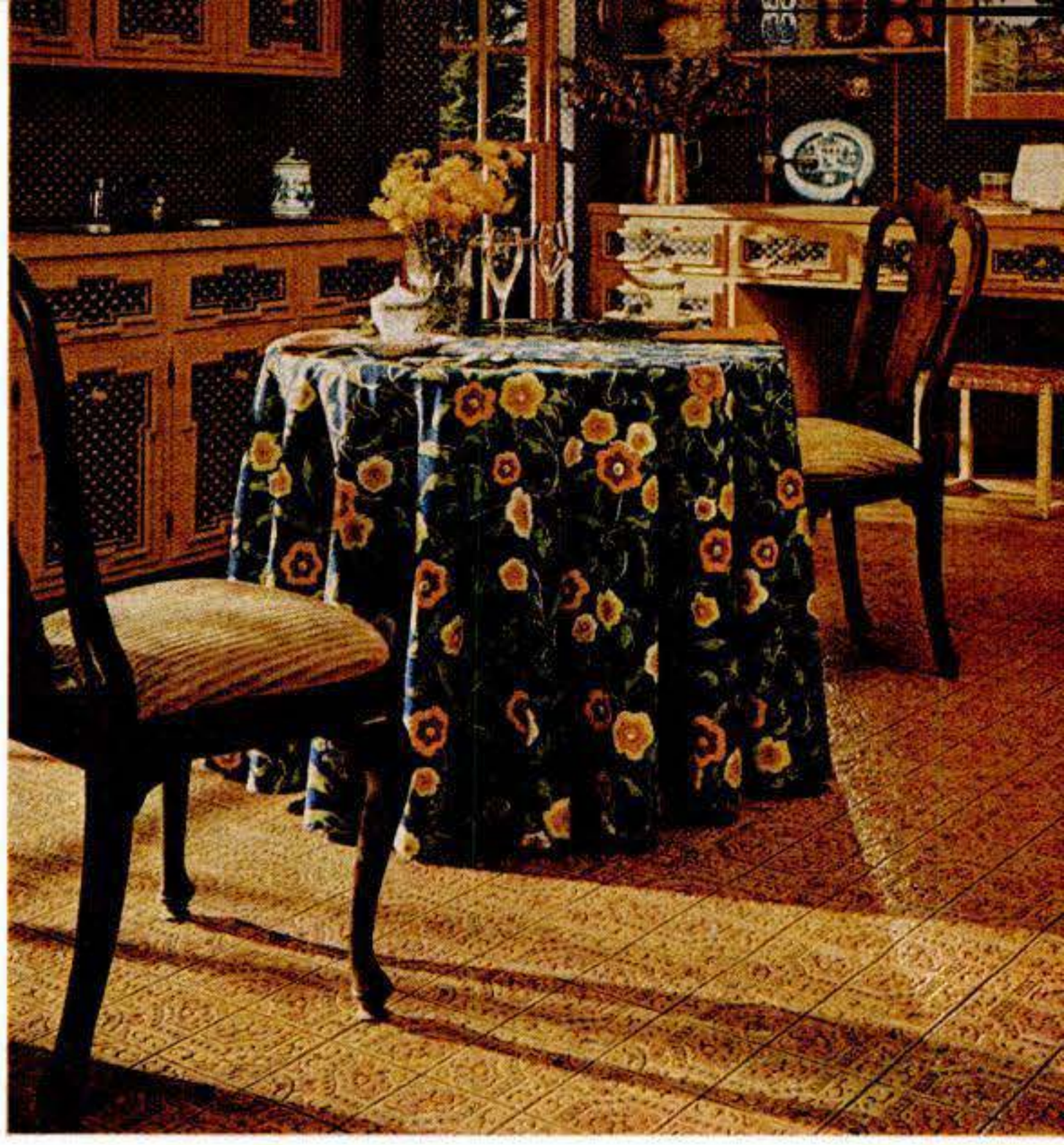
Your wife will love its underfoot comfort.

Tredway™ from Armstrong. The flexible, seamless floor you install with staples.

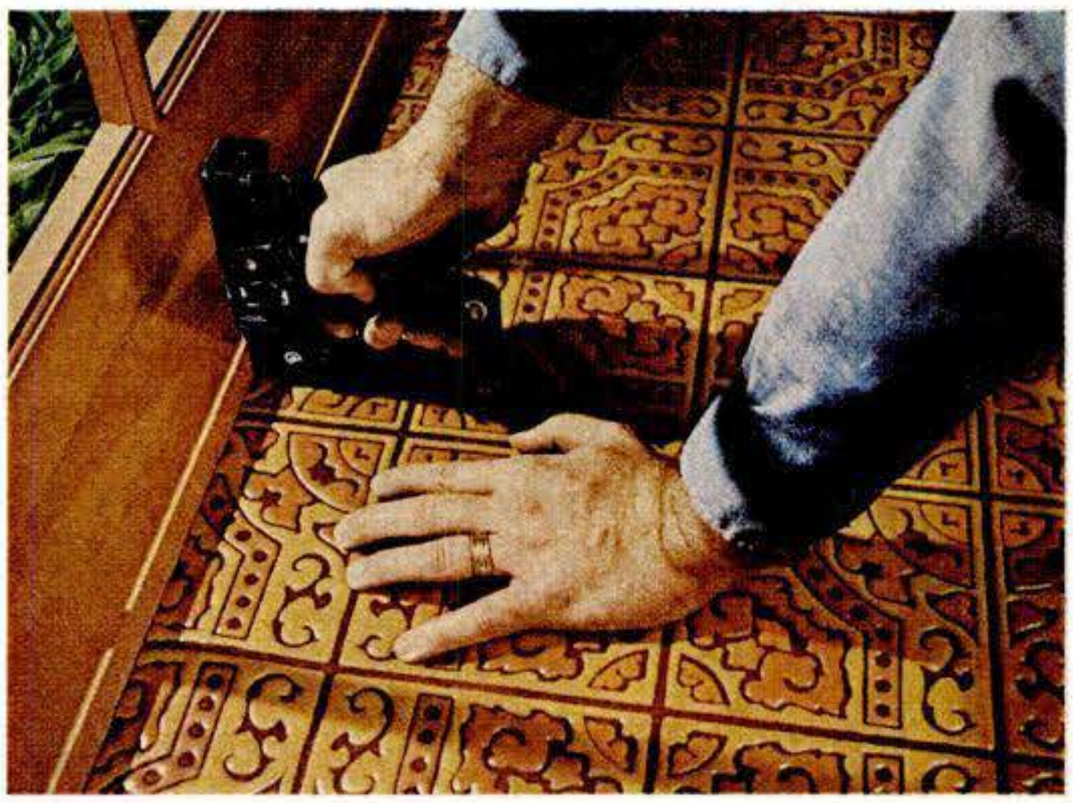


Now you can give your wife a dream of a kitchen floor—that's not a nightmare to install. It's so flexible, you can fold up enough for a whole room and carry it home. Because it's 12 feet wide, it will be seamless in most rooms. And when you install it, this same flexibility makes your job even easier.

Tredway is cushioned vinyl, to make it quieter and more comfortable to walk on. And it comes in five richly embossed designs, each in a selection of up-to-date colors, all with the look of expensive glazed ceramic tile.

Tredway is really easy to install. Here's how:

First, take up the molding around the perimeter of your room. Second, unroll Tredway and position it against the walls. Fitting and rough cutting couldn't be easier. An ordinary utility knife will do it.



Then you just staple it every three inches around the edges. (In spots where a staple gun won't reach, or over concrete, use a thin band of adhesive under the edge.) Replace the molding to cover the staples, and that's it. Since Tredway has the unique ability to adjust itself to the dimensions of your room, it will contract and stay taut to hide typical irregularities in the floor below.

Ask your Armstrong retailer to demonstrate this remarkable new floor for you. Or, send the coupon below for complete information.

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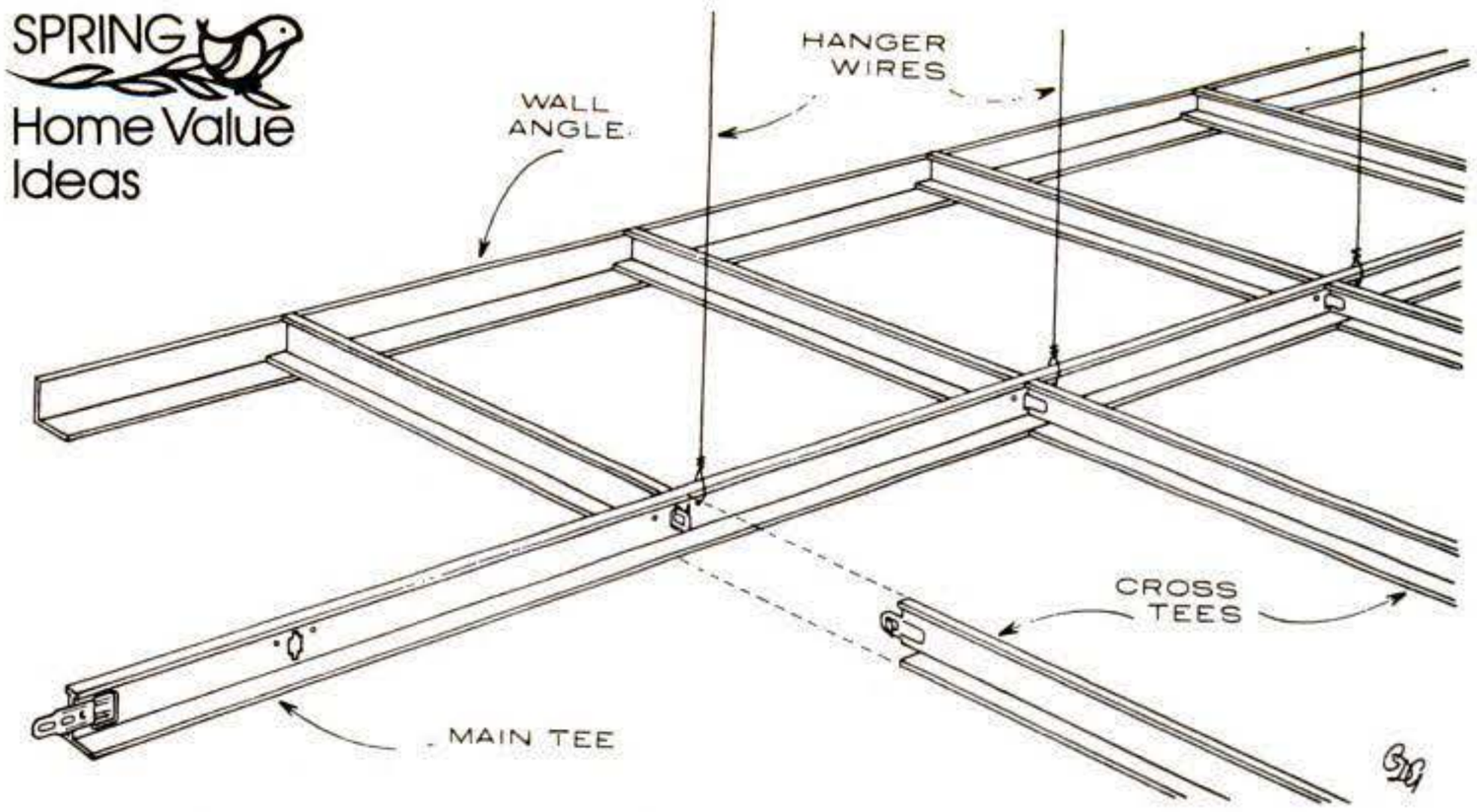
SPRING Home Value Ideas



A pro tells how to lay out a suspended ceiling

A suspended ceiling with large, removable panels is the best way to mask pipes and ductwork in most basement remodeling projects. As a salesman in the home-remodeling business, however, I've noticed that most people who plan to install a suspended ceiling are confused about how to go about it. A properly laid-out suspended ceiling will save you installation time, materials, and, of course, money. It'll also have a professional appearance instead of the patched-around-the-edges look of many home-improvement projects done by the do-it-yourselfer.

First, determine your room's dimensions and note the direction the overhead floor joists run. Now note the following facts about the metal structural elements of suspended ceilings: The structure consists of three components (see drawing above to see how they fit together):

- Wall angles in 10-foot lengths.
- Main T's or runners in 12-foot lengths.
- Cross T's in either two- or four-foot lengths.

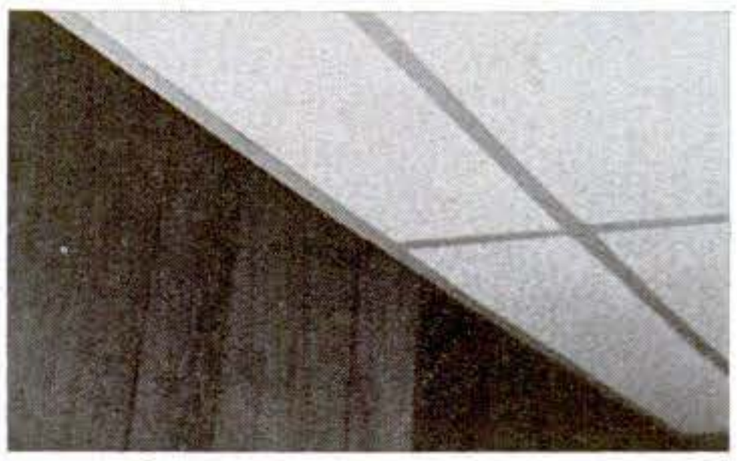
The wall angles are nailed to the walls of the room and provide the border of the ceiling. The main runners rest upon them and are suspended from the floor joists with wire. Because of this, the runners should be perpendicular to the floor joists. Main runners have male and female ends so they can be linked together for rooms that are longer than 12 feet.

The grid is completed with the cross T's. These snap in either between main runners or between a main runner and a wall angle. The lengths of the cross T's depend on the tile you're using—two feet square or two by four feet. Since room dimensions rarely turn out to be evenly divisable, both metal (the cross T's) and tile must be cut to fit. Improper planning here is where many people go wrong. Here's how to do it the right way:

First, determine the center point of the room. If the room is square or rectangular, this will be the exact center. If it's an irregularly shaped space, it will be the visual center. Then draw straight lines to the four walls of the room, making sure they cross at 90-degree angles.

Lay the ceiling tiles out on the floor, to the walls. You'll undoubtedly wind up with less than a whole tile at the wall. If it's less than half of the tile, start with a main runner at the center line; if it's more, place the middle of a tile on the center line. As an alternative to laying out tiles on the floor, draw the room to scale on graph paper, and you'll be able to plan the ceiling from that.

This method will produce a professional-looking suspended ceiling, with efficient use of all material. You will reduce wastage, and eliminate many of the frustrations of a project that needs only a little preplanning.—*Michael N. Cohen*



Poorly planned margins result in unnecessary waste of material. The margin shown above uses less than half a tile's width.

Suspended ceilings can cover up pipes, wiring, heating and air-conditioning ductwork, yet allow easy access for repairs.

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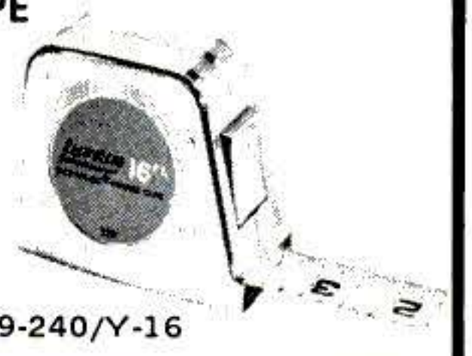

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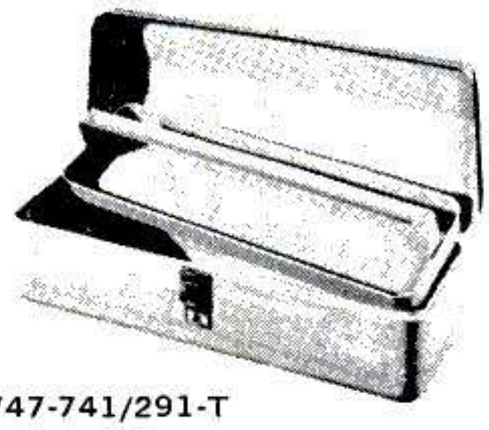

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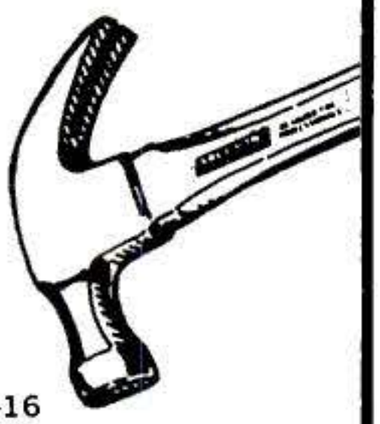

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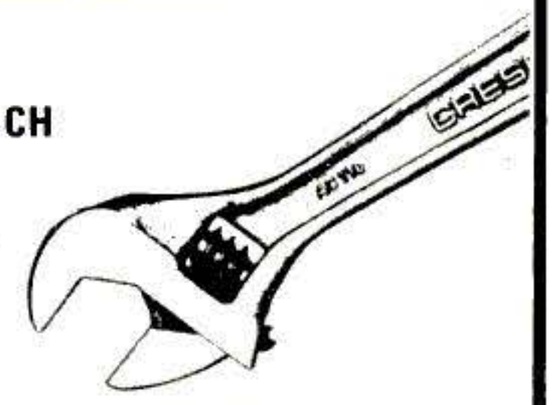

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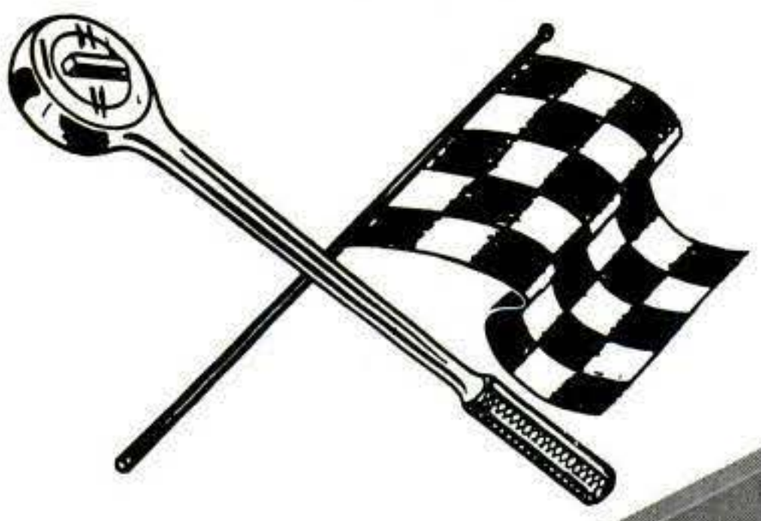

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21 pc. ¼" dr. Socket Set with S-K ratchet. No. 4921-77.
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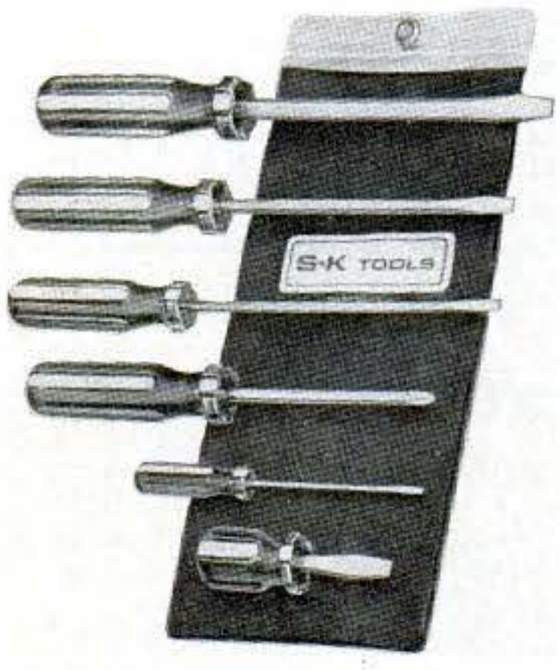

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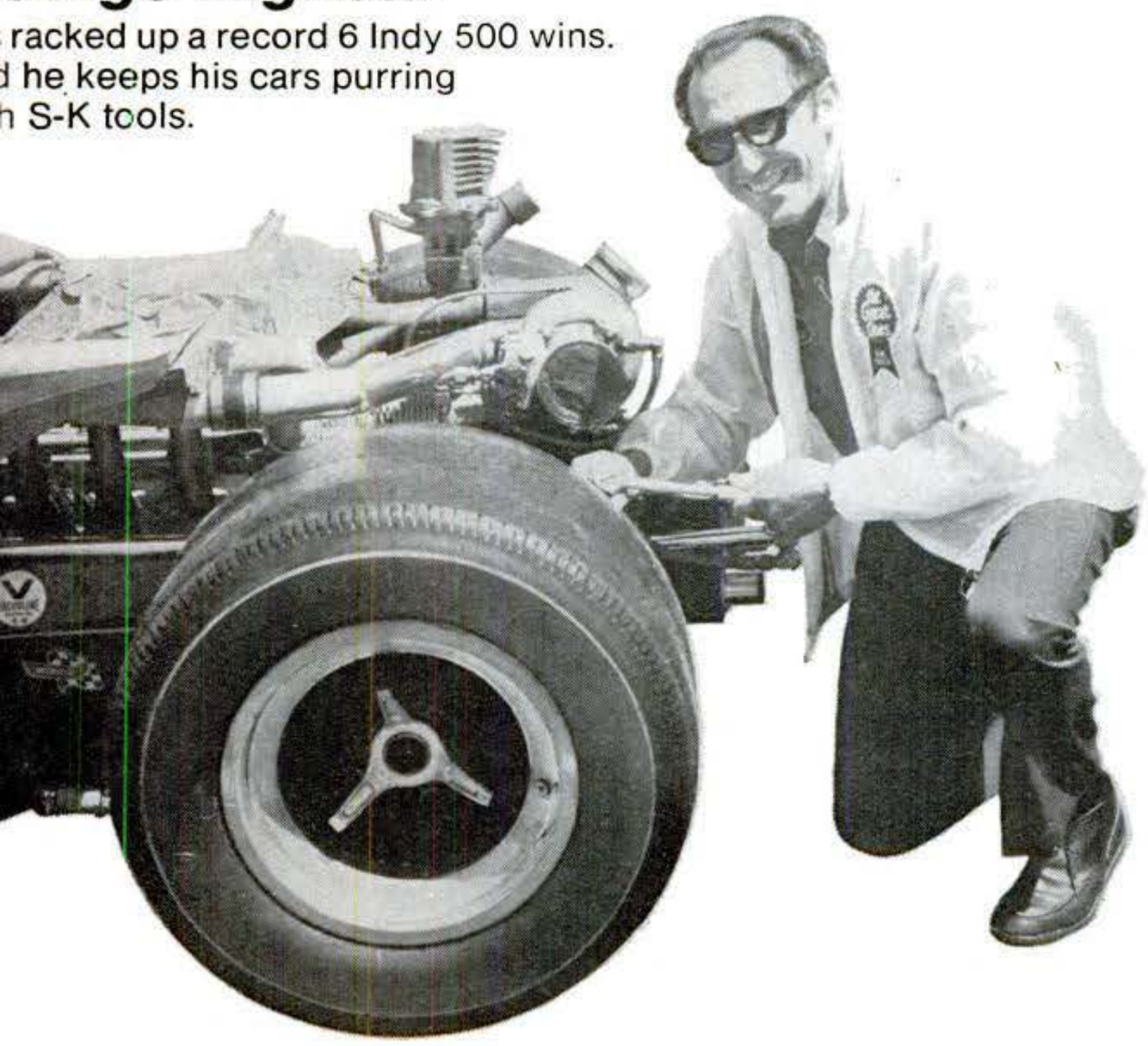

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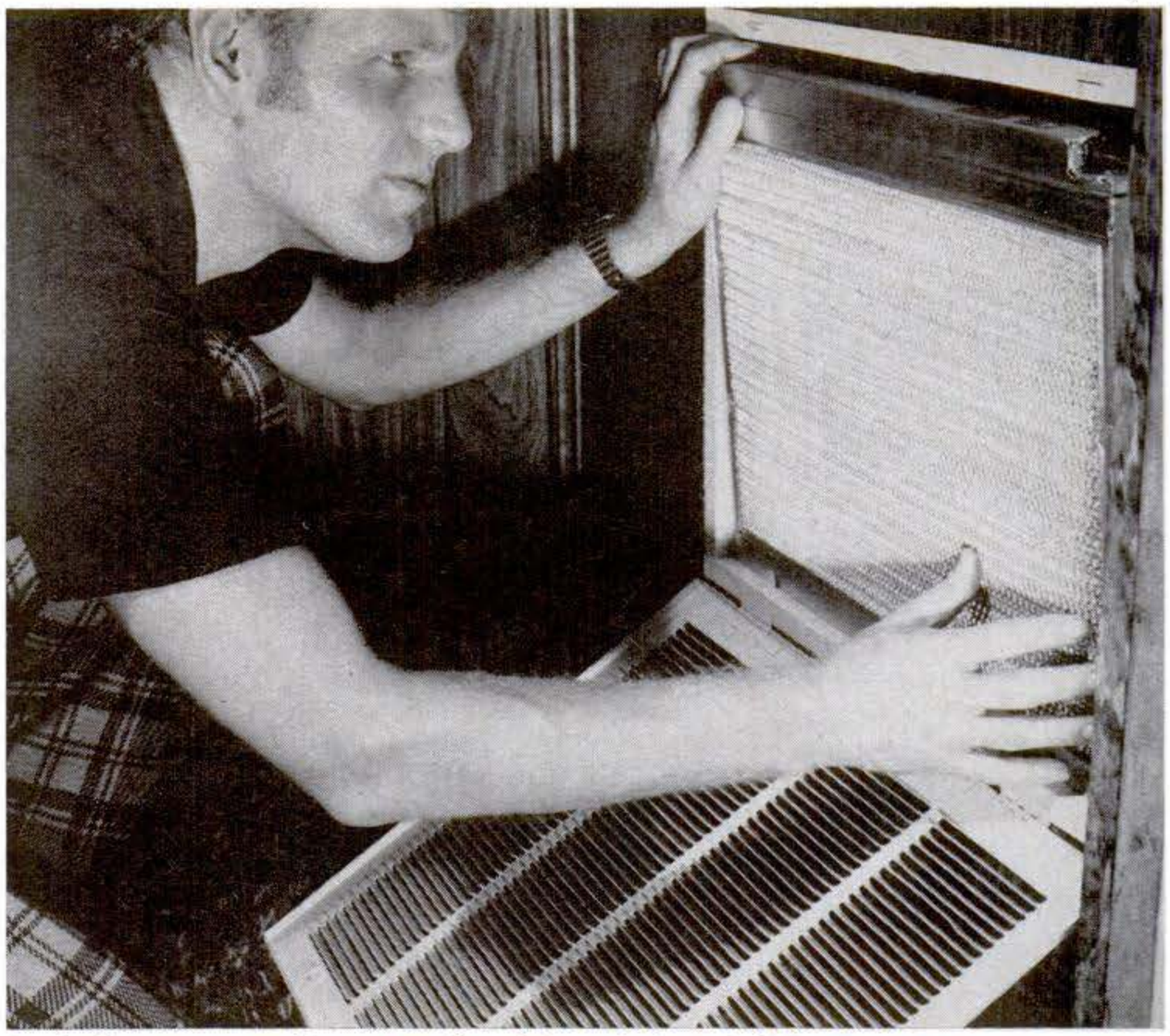
SPRING
Home Value Ideas

Electronic air cleaner slips into place



Slip-in filter traps particles as small as 0.1-micron (1/1000 mm). It replaces all standard inch-thick fiber filters and can be cleaned in the dishwasher.

Installing the typical electronic air cleaner in a forced-air heating/cooling system is no small job. It usually requires building a transition—a sheet-metal adapter to fit the return-air lines to the air cleaner—and often involves other modifications to ductwork. Air Control Industries' Porta-Pac electronic air cleaner eliminates the need for expensive modifications to your system. Its collector section is a slip-in replacement for your fiber filters. An additional advantage is that you can connect two collector cells to one power module. Thus, one Porta-Pac can serve two return-air trunk lines from different areas.

The collector cells of the Porta-Pac unit are fabricated by the manufacturer to the same size as standard one-inch-thick panel filters (and to custom sizes on special order). They simply slide in place after your old filters are removed. If your system has two-inch filters you can in-

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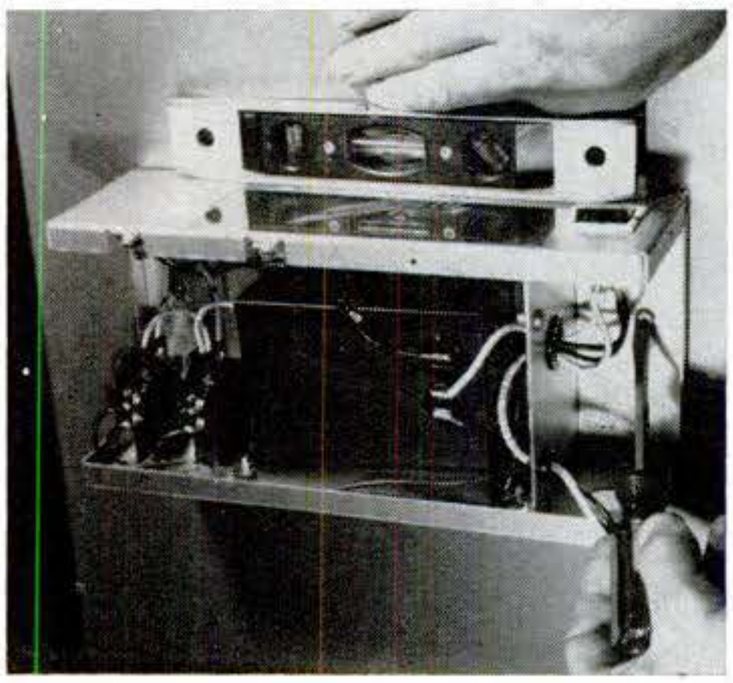
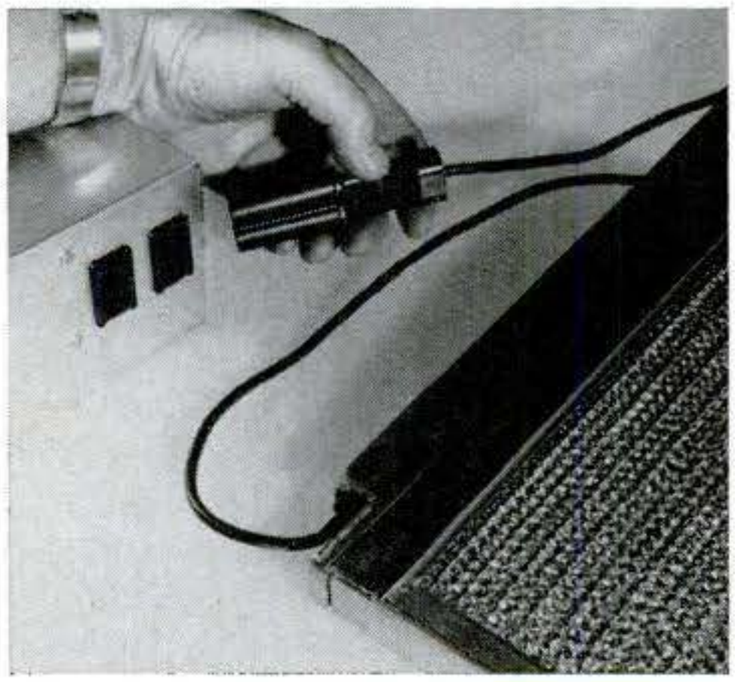
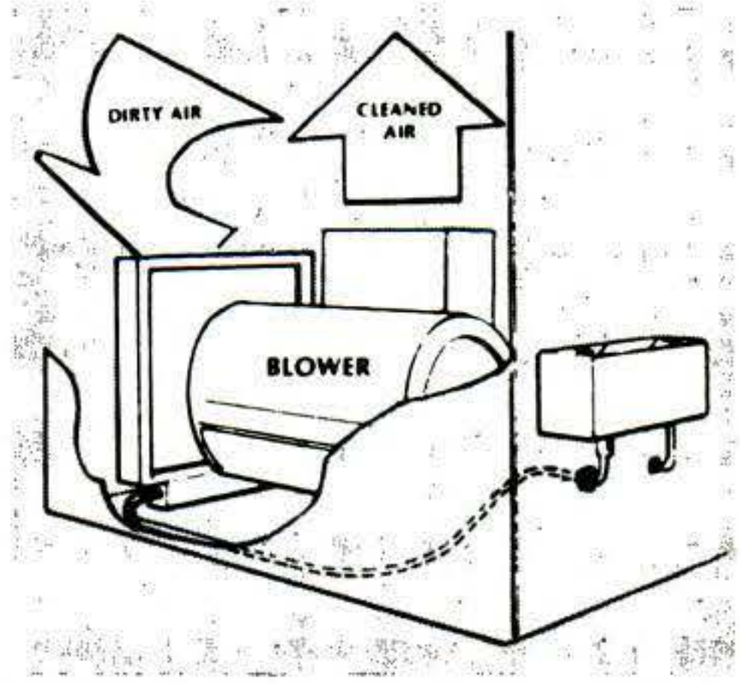


Power module mounts within reach of cell cord, is actuated by blower switch or sail switch in supply-air plenum.



Two collectors are powered by one module. Electrically charged dust particles are collected on oppositely charged plates.



Typical installation with electrostatic cleaner filtering dirty return air. Power module is sail-switch actuated.

sert a one-inch fiber filter in front of the collector cell. This fills the void and increases effectiveness.

Each cell has its own power cord that connects to the solid-state power module through a plug-in arrangement. The module can be mounted anywhere within convenient distance of the cell. Its 115-volt power supply can be controlled by the blower-fan switch or by a sail switch installed in the supply-air plenum, which will prevent the cell from operating when there is no air flow. It must *not* be connected to the speed taps of a multispeed fan motor.

Installing the air cleaner in my own system proved to be no problem. I mounted the power module, then installed one collector cell in a large filter grille located near the furnace and the other in the filter rack within the furnace itself.

In operation, I found that the one-inch-thick Porta-Pac cells in my system required cleaning more often than the thicker collector section of conventional nonelectronic cleaners. But when I experimented with using a section of polyester fiber filter material placed over the front of the filter, I found that the period between cleanings was greatly increased.

The filters are small enough to fit into most dishwashers for cleaning (after the bottom dish rack is removed). The complete cell and cord is dishwasher safe—as long as you remove it before the dry cycle. This method is convenient, but I usually have to run the empty dishwasher through an additional cycle before it's clean enough for dishwashing again.

Porta-Pac seems to offer good value in an electronic air cleaner. Its initial price is slightly lower than most. And if you require dual filters, it may be your only reasonable answer. It's available from heating and air-conditioning suppliers or from Air Control Industries, Inc., 213 McLemore Street, Nashville, Tenn. 37203.—*Evan Powell*

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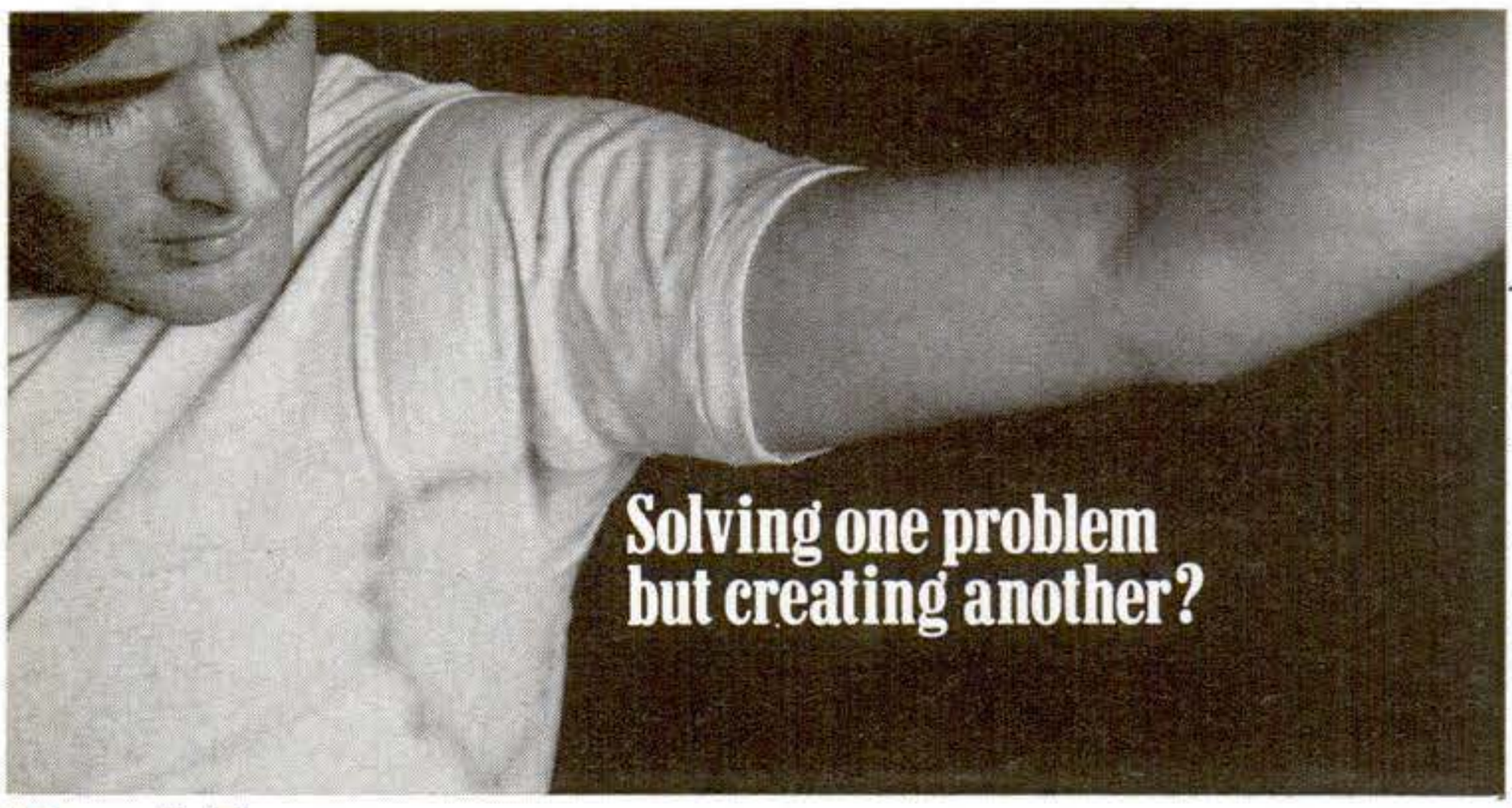

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Mennen Pushbutton Deodorant is a proven anti-stain formula. It protects against odor and embarrassing stains. So button up your underarms—switch to Mennen Pushbutton.

Your own home computer

[*Continued from page 105*]

control over the recorder, and also makes a PROM for easy keyboard entry. The hardware list of available items goes on and on, but you also get extra software availability.

Besides your own programs, you can buy prerecorded ones that preprogram the computer to talk to you in another more direct language, called BASIC. And, once that's loaded into the computer, you can then load more prerecorded programs like Startrek, which are written in the BASIC language format.

Needless to say, I've gone full circle with the IMSAI. I must now learn to program in 8080 language, use all the inputs and outputs properly, and take advantage of the programs included in the IMSAI kit. Those programs will take time, however, since they are punched on paper tape—another form of input—and I'll have to get an optional paper-tape reader to load them into the computer.

The months of work I've put into this project have been well spent. The MITS 680b, which proved to be invaluable as a teaching aid, is now being put to work in two ways at home. It's connected to a Micon TV terminal (a complete preassembled terminal that's slightly larger than a cigar box) and to a small-screen TV. The system stores phone numbers, appointments, recipes, names, addresses, and even our "things to do today" list. It gives us as much, or as little, information as we want on a particular subject. If you asked for "cookies," for example, it would give the recipe of every type of cookie stored in its memory. But if you asked for "chocolate-chip cookies," you would get only that specific group of ingredients.

A cable links the MITS with the IMSAI downstairs in my shop. A small 15-instruction program in the IMSAI allows it to have access to the information stored in the MITS. I can retrieve the same information as I can upstairs, or enter new data—like shop records. And, at the same time, the IMSAI can be used for BASIC programming and experimentation. As I learn more programming, I intend to give the system more meaningful jobs: Compute our tax returns in different ways to give us the best results; keep watch over fuel bills, noting if added insulation makes a significant difference (depending on the time of year); compute interest on bills versus bank interest, determining when they should be paid, and store learning games for our children that would become progressively harder as they grow older.

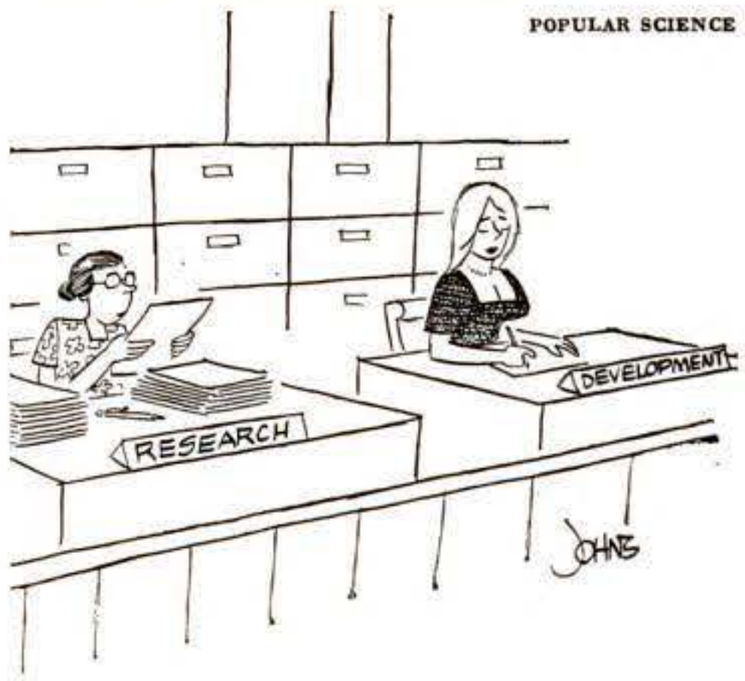
The result of all this is not only a futuristic tool for our home, but a brand-new and fun hobby. MITS, IMSAI, and Southwest Technical are just some of the old pros in the field, but there are new makers getting into it every day.

Radio Shack, for instance, now offers a packaged keyboard kit you take off the shelf, with plans for a complete computer kit coming up later this year. Motorola is making a computer in a book. It actually began as an engineering demonstration kit, but it's now being offered to the hobbyist.

And it's very reassuring to know that companies and their dealers are very helpful. MITS and IMSAI, for instance, have special departments for helping anyone in trouble. I got simple, direct answers from the Computer Store, a distributor for MITS; and Williams Electronics Supply, a distributor for IMSAI and Southwest Technical Products equipment. Add to that new national magazines like *Byte* and *Interface Age*, plus the computer clubs sprouting all over the country (a dealer will tell you the ones in your area), and you'll find you're never alone pursuing this new and interesting hobby. PS

Manufacturers and distributors:

Electronic Control Technology, Box 6, Union NJ 07083; **Enclosure Dynamics Inc.,** Box 6276, Bridgewater NJ 08807; **IMSAI Mfg. Corp.,** 14860 Wicks Blvd., San Leandro CA 94577; **Micon Industries,** 252 Oak St., Oakland CA 94607; **MITS Inc.,** 2450 Alamo SE, Albuquerque NM 87106; **Motorola,** Semiconductor Products Division, 3501 Ed Bluestein Blvd., Austin, TX 78721; **National Multiplex Corp.,** 3474 Rand Ave., S. Plainfield, NJ 07080; **Radio Shack** (local stores); **Southwest Technical Products, Corp.,** 219 W. Rhapsody, San Antonio TX 78216; **The Computer Store,** 55 W. 39th St., New York NY 10018; **Williams Electronic Supply,** 1863 Woodbridge Ave., Edison NJ 08817.



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[Continued from page 108]

pairs or gear changes. That's not surprising, if you've ever worked with gears and bearings—in the differential of a car, for example. Great precision in positioning, centering, backlash adjustment, and bearing preloads is necessary if you don't want to have a noisy, gear-grinding mess. That goes double for stern drives.

Thus, OMC, Merc, and especially Volvo make much of matching gears, selective fits, and factory preassemblies. Chrysler, however, says that it shapes its gears with sufficient precision and machines its drive housing so that it does not need matched sets. In short, your dealer can replace one gear in a set and it will run fine.

Lubrication

OMC lubricates the gears and bearings with a spiral, worm-like oil circulating device on the drive shaft. Volvo has a small centrifugal oil pump on the prop shaft, but Chrysler and Merc say that the action of the working parts gives enough oil circulation.

Recommendations for lubrication vary widely:

- OMC insists on special lube, never EP-90, and a yearly change.
- Merc says special lube will double gear life over the second best lube they know of, but doesn't insist on a yearly change.
- Chrysler says standard gear lube is okay—even motor oil in an emergency. It doesn't insist on special lubes—"nobody will do it anyway."
- Volvo recommends 10W/30 or 20W/40 engine oil; change at 100 hours or at least once a season.

The makers don't agree about freshwater cooling, in which a separate supply of water is contained in the engine cooling system and is used over and over, just as in your car. The system uses a heat exchanger instead of a radiator and transfers heat to the raw water also passing through the heat exchanger, just as air passes through a car's radiator.

Raw-water cooling simply pumps lake or ocean water into and out of the engine under thermostatic control. The advantage of freshwater cooling is that you can treat the water to inhibit corrosion and keep it clean. OMC doesn't think it's often needed, and says it also means you've got two cooling systems to pay for initially, and more maintenance later. It doesn't offer freshwater cooling but does suggest a 10-minute freshwater rinse after operation in saltwater.

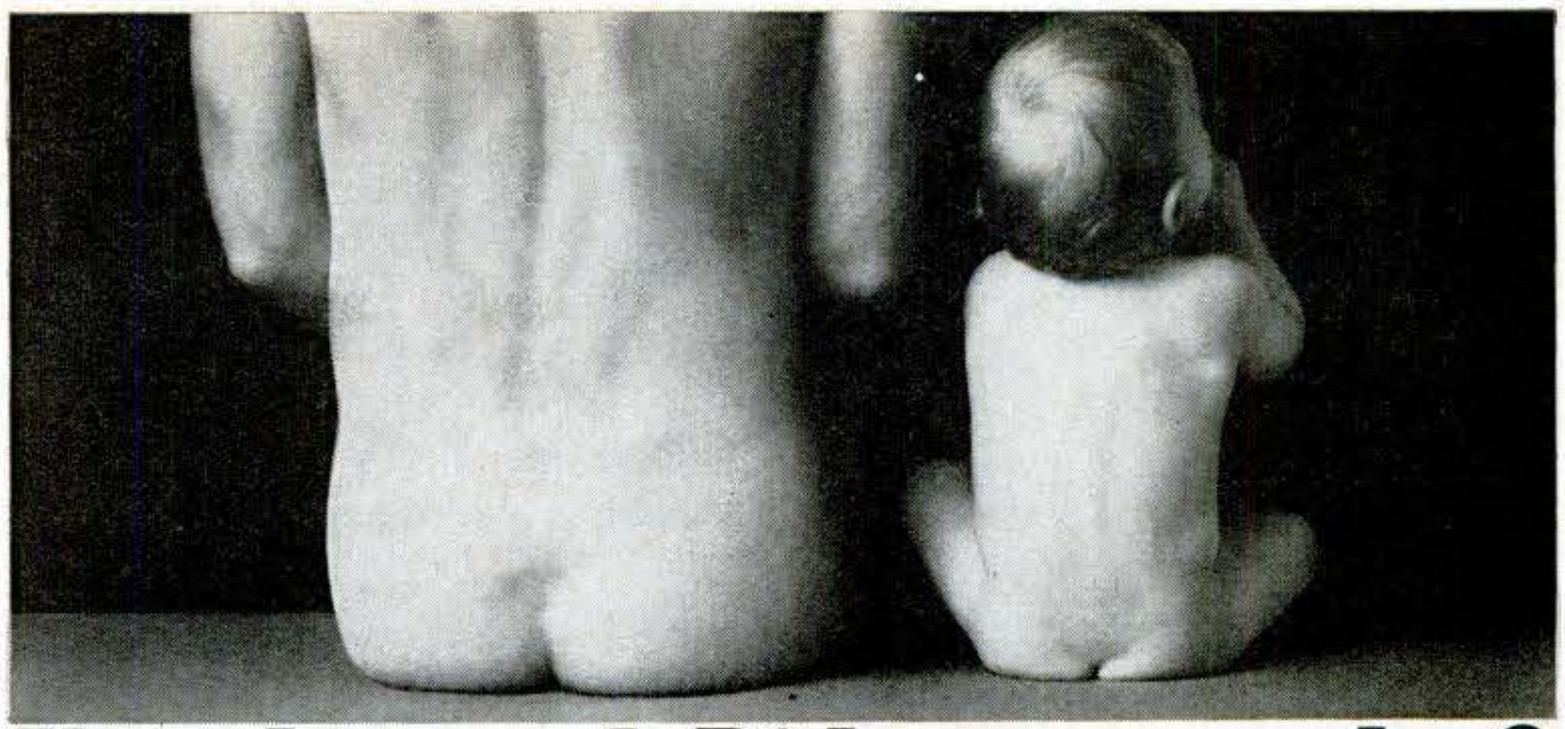
The new MerCruiser 470 aluminum-block engine has cast-iron heads, and hence dissimilar metals with the possibility of corrosion. This is one I/O model in which freshwater cooling is standard. On other models Merc offers freshwater options, as do Chrysler and Volvo. Basically, however, raw-water cooling is standard, so if you plan to buy an I/O, you should find out whether there are any special conditions in your waters that might make the freshwater option more desirable.

Substituting auto parts

With the exception of Merc's 470 I/O, power plants are converted automotive engines. Just how extensive the conversion is depends upon the individual engines and may even vary with the same engine from model year to model year.

Valve seats, for example, used to be especially hardened for marine use, but as automotive engines have been forced to cope with lead-free gas, many automotive seats and valves may now be suited for marine use without being specials. OMC stresses that a great many parts, camshafts, pistons, water pumps, and so on, are often specials or have special fits and clearances. In its parts catalog, you'll find that many parts that may be look-alikes to automotive parts are flagged, because they are really different and not interchangeable. One point OMC makes emphatically is that substituting automotive starters, alternators, distributors, circuit breakers, and carburetors can be very dangerous. Such equipment has been carefully developed and tested to reduce marine fire hazards. Even though automotive units may fit the bolt holes, they could cost you your boat—or worse.

Mercury says much the same thing, although its parts catalog is not flagged in the same way. Chrysler engineers say that highly specialized internal parts are minimal in their engines and that they often buy repair parts for their own lab engines from the local Plymouth dealer. This free-and-easy potential for picking up will-fits from your local garage or parts shop doesn't quite apply to Volvo, which doesn't mention it as a problem in its owner's manual. PS



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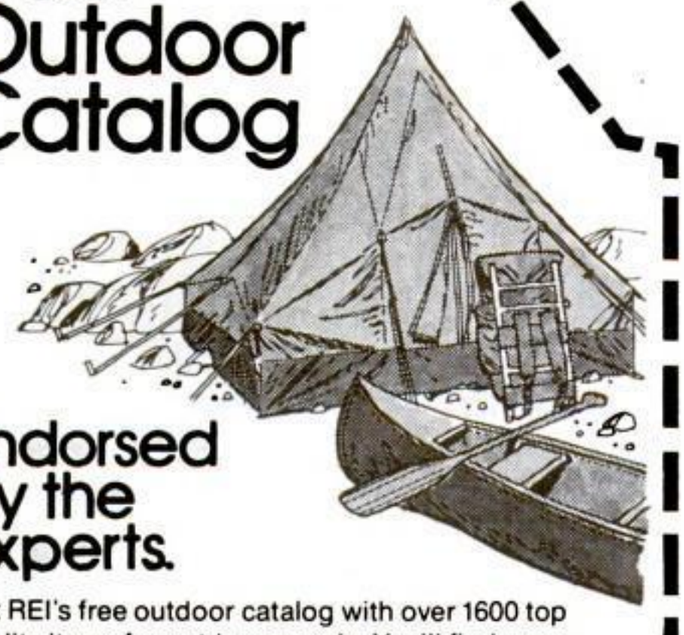

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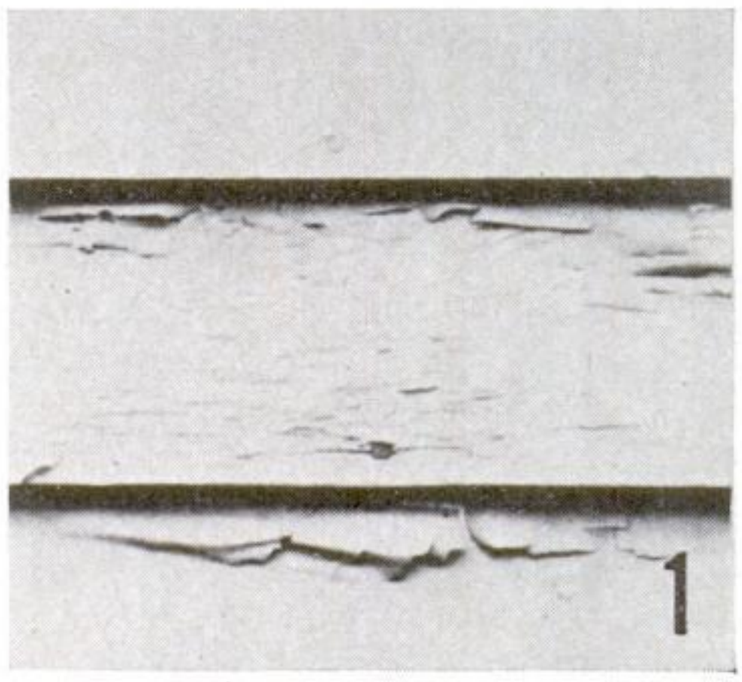
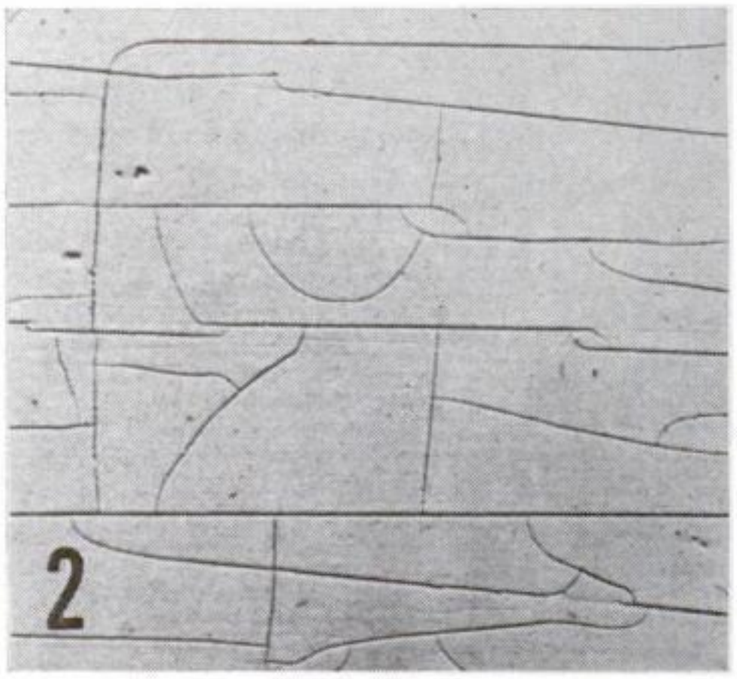
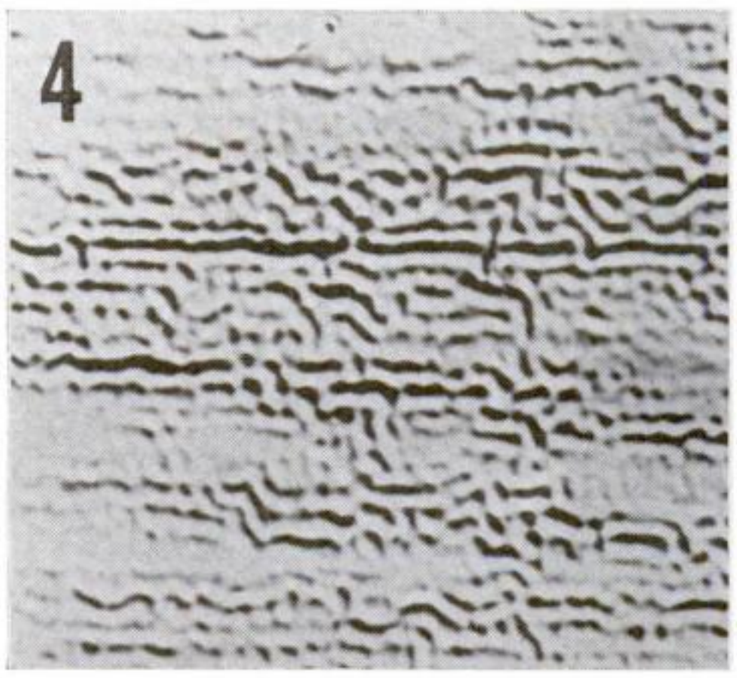
SHOP TALK

By RICHARD STEPLER







Brush off paint problems

If your home's wooden siding exhibits any of the blemishes illustrated above, it's time to break out the paint and get to work—before more serious damage results. Here's how to deal with these common paint failures:

1) Blistering and peeling: The cause is usually moisture. Water vapor generated by indoor activities such as cooking and washing migrates through the siding and loosens the film of paint from behind. Prevent it by installing exhaust fans in kitchen, bath, and other high-humidity areas to vent excess moisture outdoors. Tiny aluminum or plastic vents can be placed in the siding itself to stop moisture buildup. Sears sells the vents, and a drilling guide for installing them. If you can't remove blistered paint by sanding, scraping, or wire-brushing, Sears also sells an electric paint remover and burn-off knife. (See pages 118 and 120 of our April '75 issue.) Once old paint has been removed, prime the wood and apply good-quality exterior paint.

2) Cracking: Old paint that has dried to an excessively hard finish will not expand and contract with the wood, so cracks develop. Wire-brushing and repainting should solve it. Removing paint to bare wood is a sure cure.

3) Alligatoring: Caused by incompatible coats of paint, or by applying a second coat before the first has dried. Remove faulty coats and repaint.

4) Wrinkling: You've applied too heavy a coat of paint or haven't properly brushed it out. Sand and repaint.

Make that a 10-mm drill

Beginning January 1, 1978, all of Black & Decker's new products and accessories will be measured in metrics. To help us make the transition, B&D will use dual metric/inch specs in its catalogs and literature. The company doesn't intend to convert all existing products to metrics immediately. Eventually, though, we'll be buying 10-mm portable electric drills instead of those ⅜" models.

Icosahedron

While it may look haphazardly rustic, this cabin's shape is derived from the icosahedron, a 20-sided geometric shape. Called Eco-Cabin, its roof and walls consist of 15 triangles; the floor, a pentagon nine feet on a side, provides 120 square feet of living space. Why

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a complex shape for a small cabin?

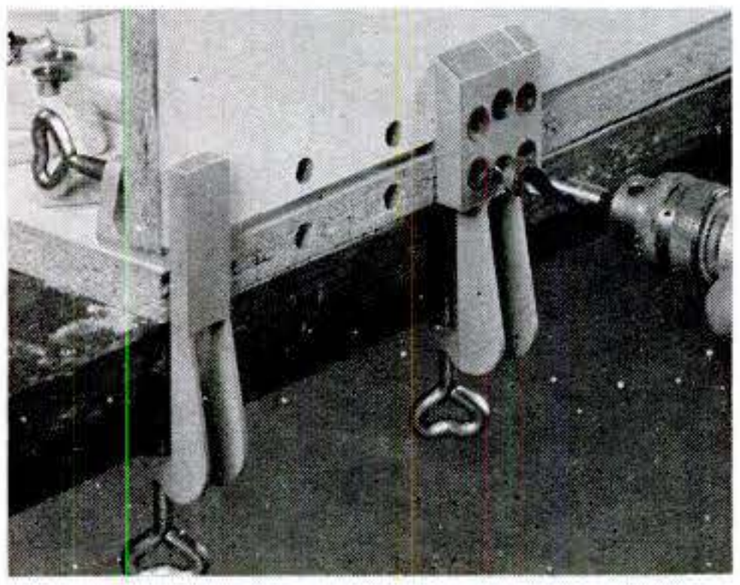
"Because of simplicity of design, economy, ease of construction, great structural strength, and maximum use of minimum amount of material," say the folks at Greenpeace Experimental Farm, developers of Eco-Cabin. It's ideal for a remote site, since all components could be prefabricated, then assembled on-site without power tools. Impact on the environment is minimized, too, since Eco-Cabin's foundation is post and

beam. GEF estimates that you could erect the cabin for $600.

Want to build it? "The Eco-Cabin: Plans for the Owner-Builder" is $3.50 from Greenpeace Experimental Farm, R.R. 1, Denman Island, B.C., Canada.

A U.S. source

The ingenious West German-made doweling jig reported on by PS European



editor David Scott in last month's issue (page 58) is now available in the U.S. Coastal Abrasive & Tool Co. (Trumbull, Conn. 06611) offers the die-cast-aluminum doweling jig clamps for $16. The pair of clamps lets you drill accurately matched holes for three dowel sizes: ¼", 5/16", and ⅜" (6, 8, 10mm).

Dial solar

Want technical information on solar heating or cooling? You can dial HUD's National Solar Heating and Cooling Information Center toll-free: (800) 523-2929. The service is designed for builders, engineers, architects, scientists—and the general public. Written requests should be sent to the Center at Box 1607, Rockville, Md. 20850. PS

GET INTO THE STEAM OF THINGS

This steam engine kit is an ideal project for these cold winter evenings. It machines on a very small lathe such as the Unimat or the Sears/Atlas 6" and will prove that you are a better machinist than you think. Or, it makes a great project for school shop. The kit has all the parts you'll need, including complete drawings and instructions. It's a lot for $6.95, postpaid.

Building engines like this is the hobby of *Model Engineering*. We have thousands of things along this line. Order our FREE catalog or start with some books like these: The Beginners Workshop, $7; Building a Steam Engine from Castings, $2; Model Stationary and Marine Steam Engines, $7; Virginia, constructing a live steam locomotive, $10.95

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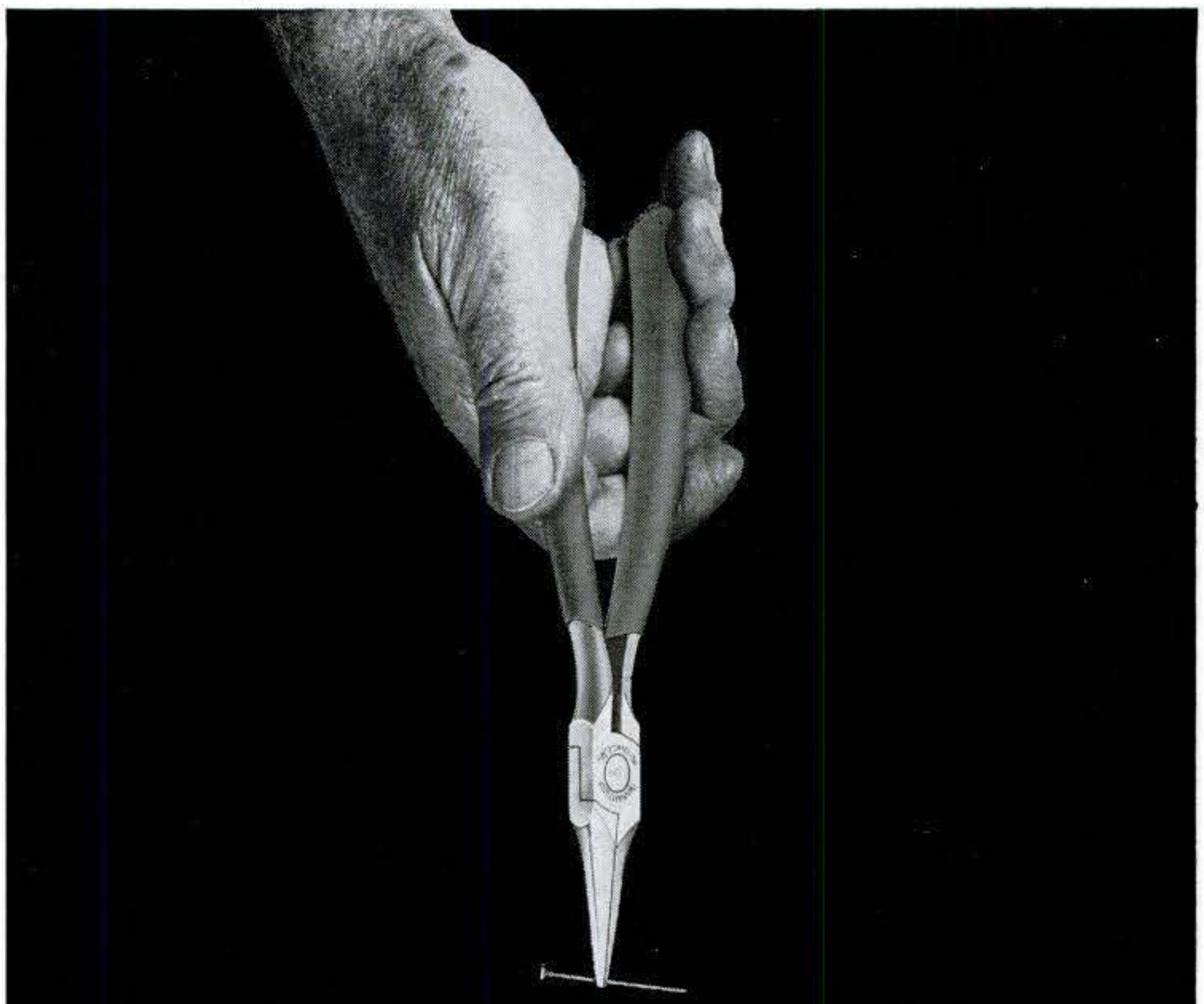

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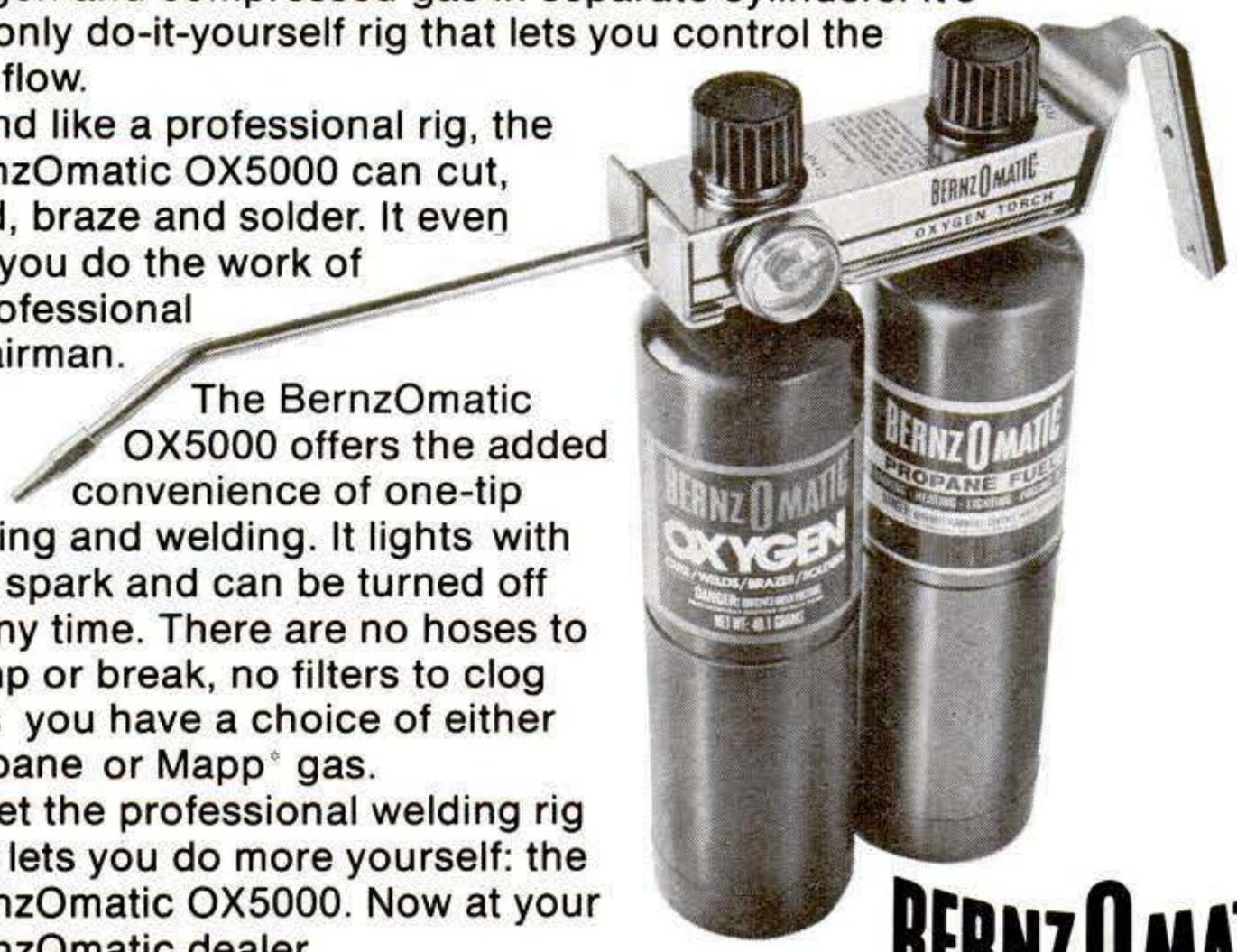

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BERNZOMATIC®

Masonry floors

[Continued from page 116]

needn't empty your wallet. Price of the marble will probably range from $3 to $10 per square foot. And if you have a contractor install it, figure on $3 per square foot or more for installation costs. (Intricate cutting and fitting can drive this way up.) Installing a marble floor yourself is a substantial undertaking, but it does save money. And many marble distributors will rent you the tools you need, including carborundum saw blades. Thin marble tile (usually squares or rectangles) suitable for residential flooring can be installed over nearly any subfloor that has been reinforced.

After installation, marble floors should be sealed with a sealer made for the purpose (white and dark marbles require different sealers). If you clean and reseal the marble every six months, your floor should stay sparkling.

Terrazzo

A terrazzo floor is made up of marble chips in a binder of either portland cement or a resinous material, or a combination of both. After this is poured, the surface is ground to create a smooth floor in which the chips of marble look like tiny irregular mosaic pieces. Divider strips of plastic, white metal, or brass enhance the appearance of a terrazzo floor, and also create a "weak point" so that any cracking will be localized.

Laying a terrazzo floor is not a job for the inexperienced. The grinding, especially, requires skill. The installed cost of terrazzo averages around $2.50 per square foot.

If after installation a terrazzo floor looks cloudy, it's probably because lime from the cement binder was never completely removed from the surface. To remove the lime, you need a neutral (neither acid nor alkali) *detergent*—not soap.

Once the floor has been thoroughly cleaned you may want to seal it to protect the cement from stains. Use a penetrating sealer for this; wax is not recommended. PS

SOURCES FOR PRODUCTS AND INFORMATION

(For local distributors, look in the Yellow Pages, or contact the firms listed below:)

Building Stone Institute, 420 Lexington Ave., New York, N.Y. 10017.

Terrazzo and Mosaic Tectonics Service, P.O. Box 3765, Grand Central Sta., New York, N.Y. 10017.

Tile Council of America, Inc., Dept. DIY, P.O. Box 2222, Princeton, N.J. 08540.

Vermont Marble Co., Proctor, Vt. 05765.

Vermont Structural Slate Co., Fair Haven, Vt. 05743.

Vetter Stone Co., Kasota, Minn. 56050.

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By ROY DOTY

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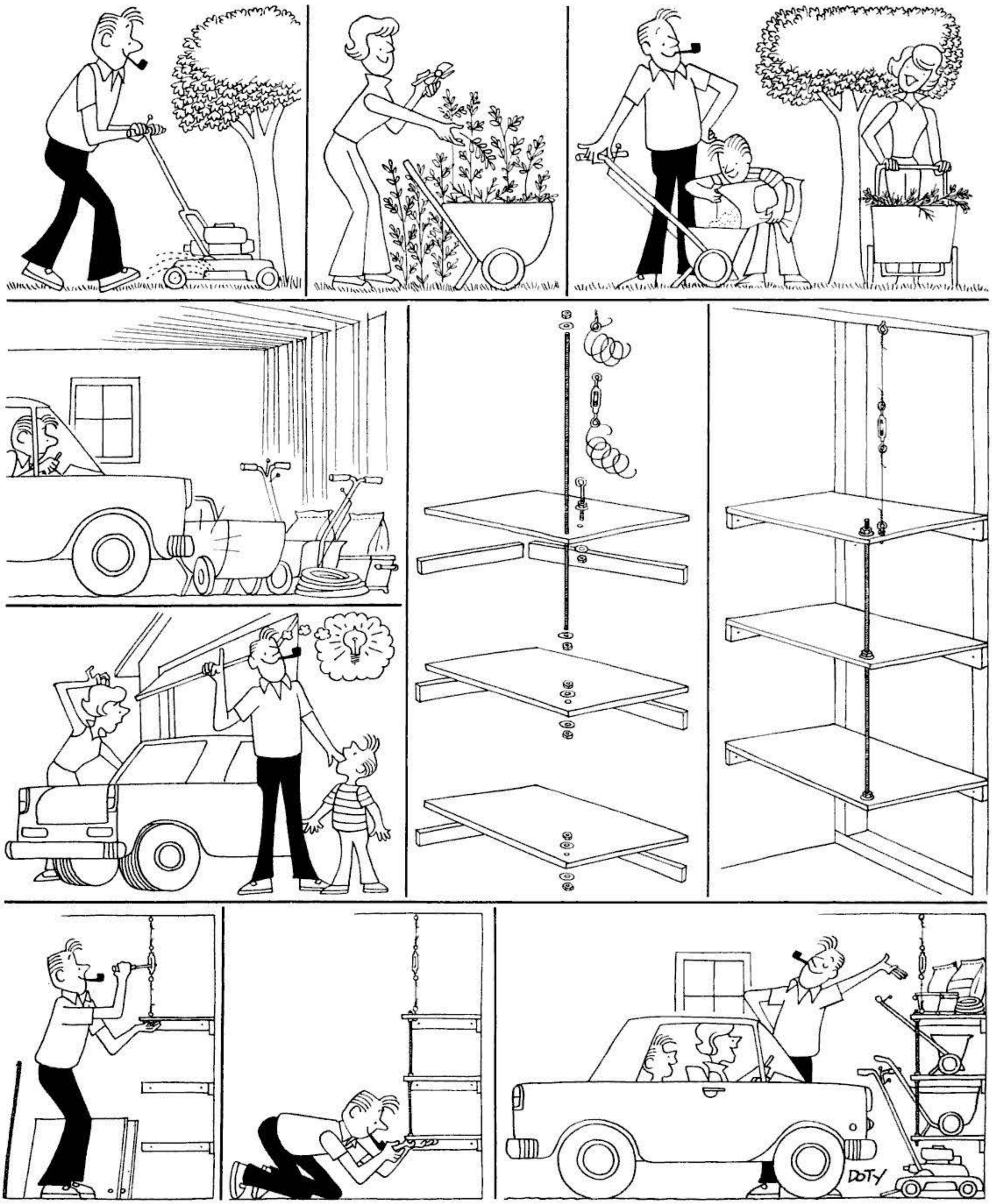

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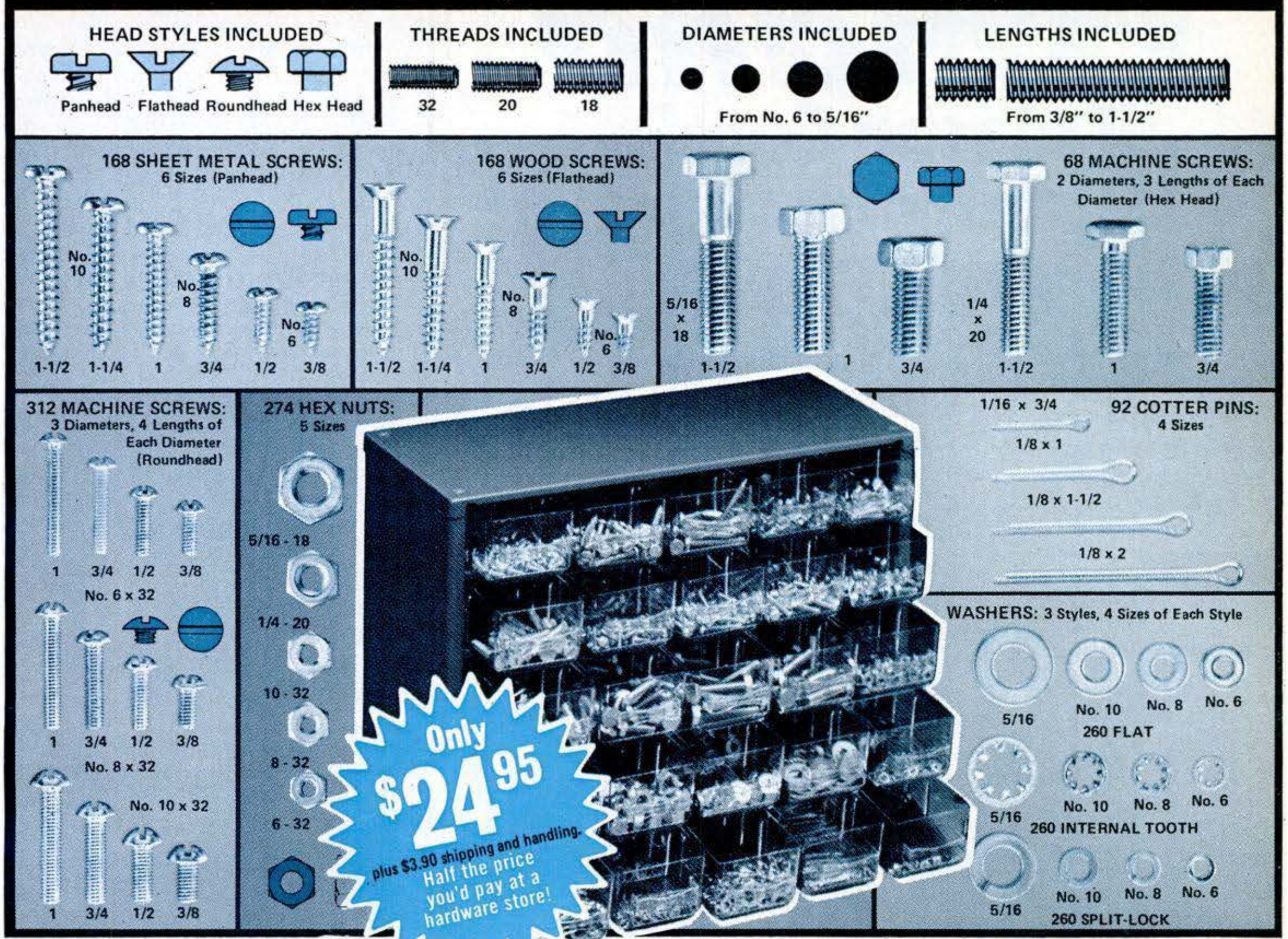

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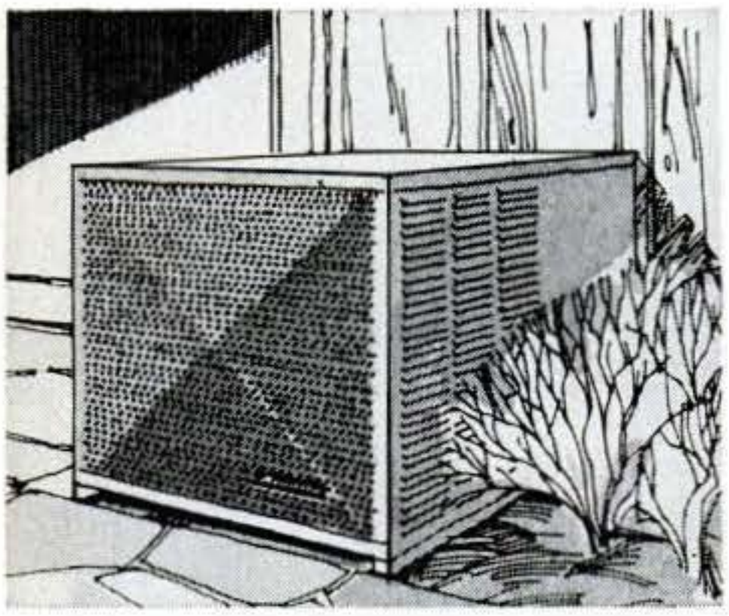

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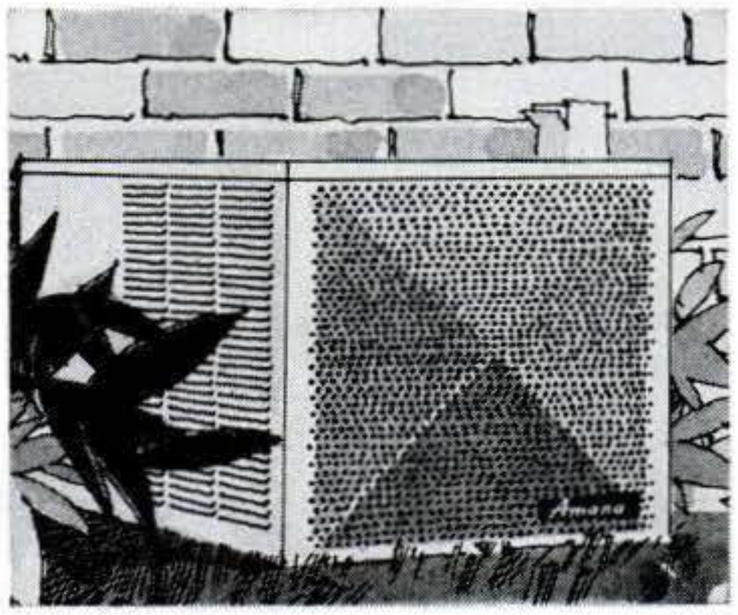

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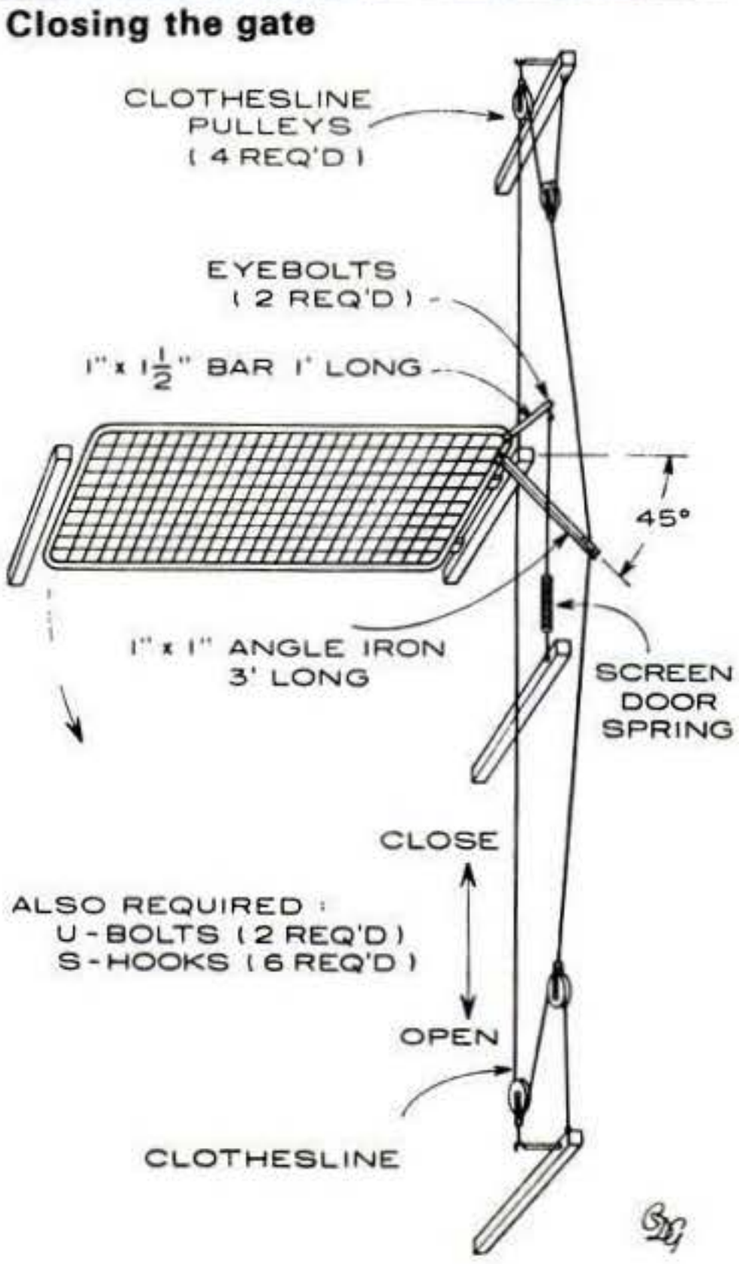
Opening the gate

Closing the gate



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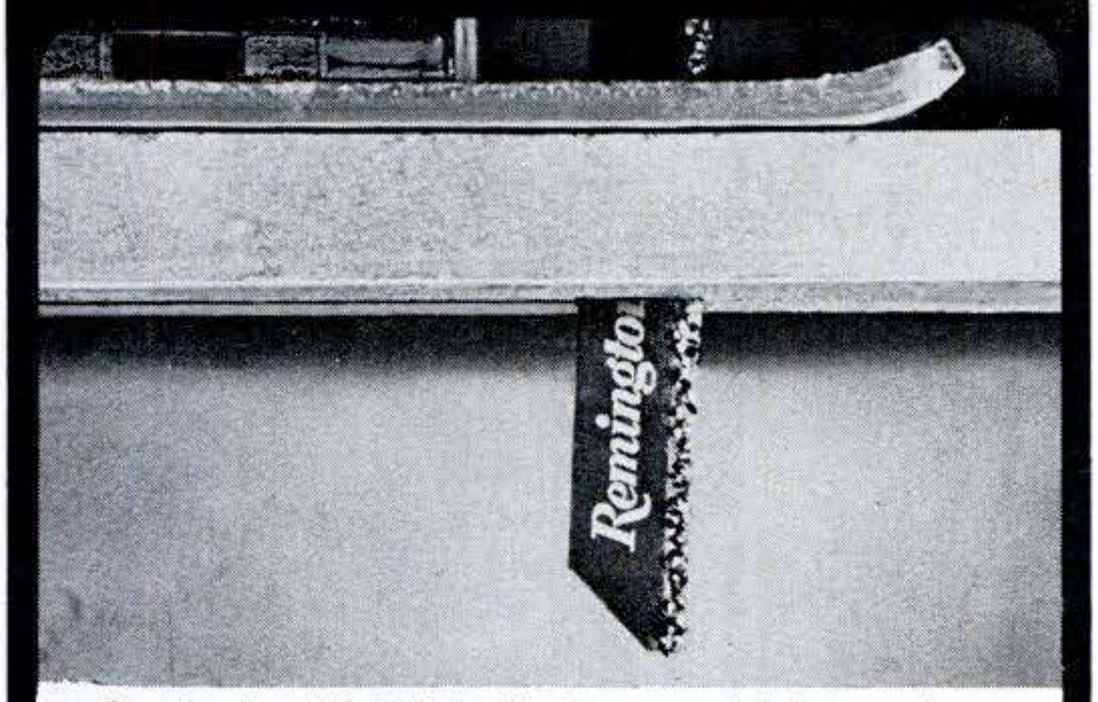
"Grit-Edge" blades saw asbestos-cement.



Remington "Grit-Edge" saber saw blades make contour cuts in asbestos-cement, fiberglass, synthetic marble and plenty of the other "unsawables".

Tungsten carbide particles permanently bonded to steel make "Grit-Edge" blades just the cutting tools to saw hard and brittle materials with a smooth-edge finish.

Economical, durable "Grit-Edge" blades. Tough enough to take on almost anything.

For more information, see your hardware dealer or write: Abrasive Products, Dept. 697, Remington Arms Company, Inc., Bridgeport, Conn. 06602.

GRIT EDGE When ordinary blades can't cut it. **Remington** DU PONT

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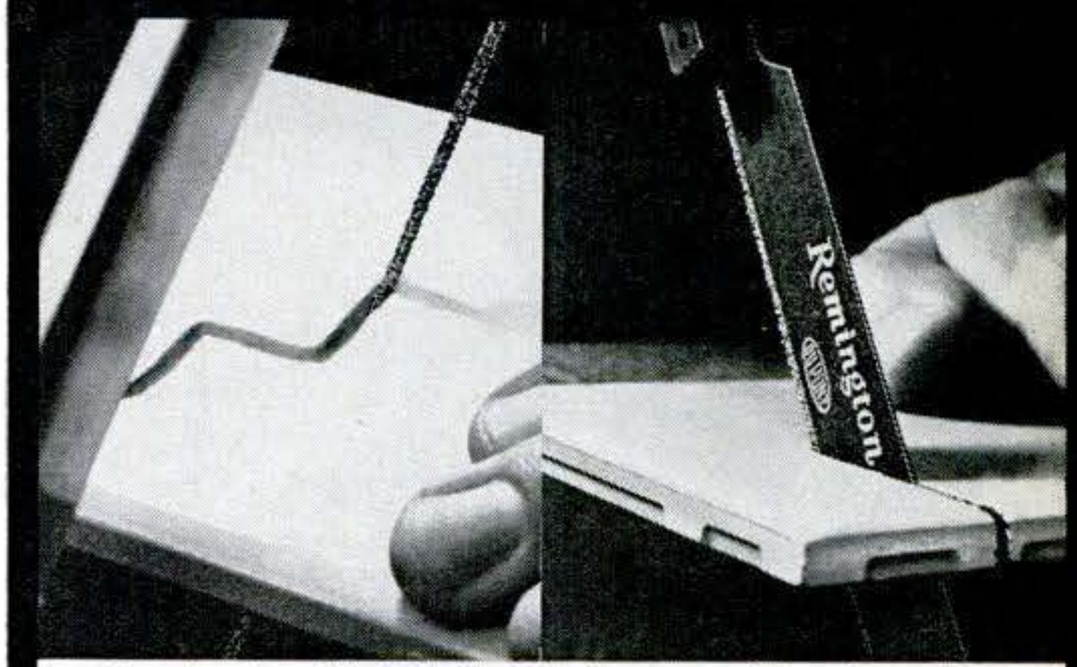
"Grit-Edge" blades trim tile with style.



Remington "Grit-Edge" rod saw and hacksaw blades make contour cuts in ceramic tile, snag-free cuts in high-pressure hose, cuts at any angle in hardened steel, space-age alloys and plenty of the other "unsawables".

Hundreds of tungsten carbide particles permanently bonded to "Grit-Edge" blades make them a match for materials conventional blades can't tackle.

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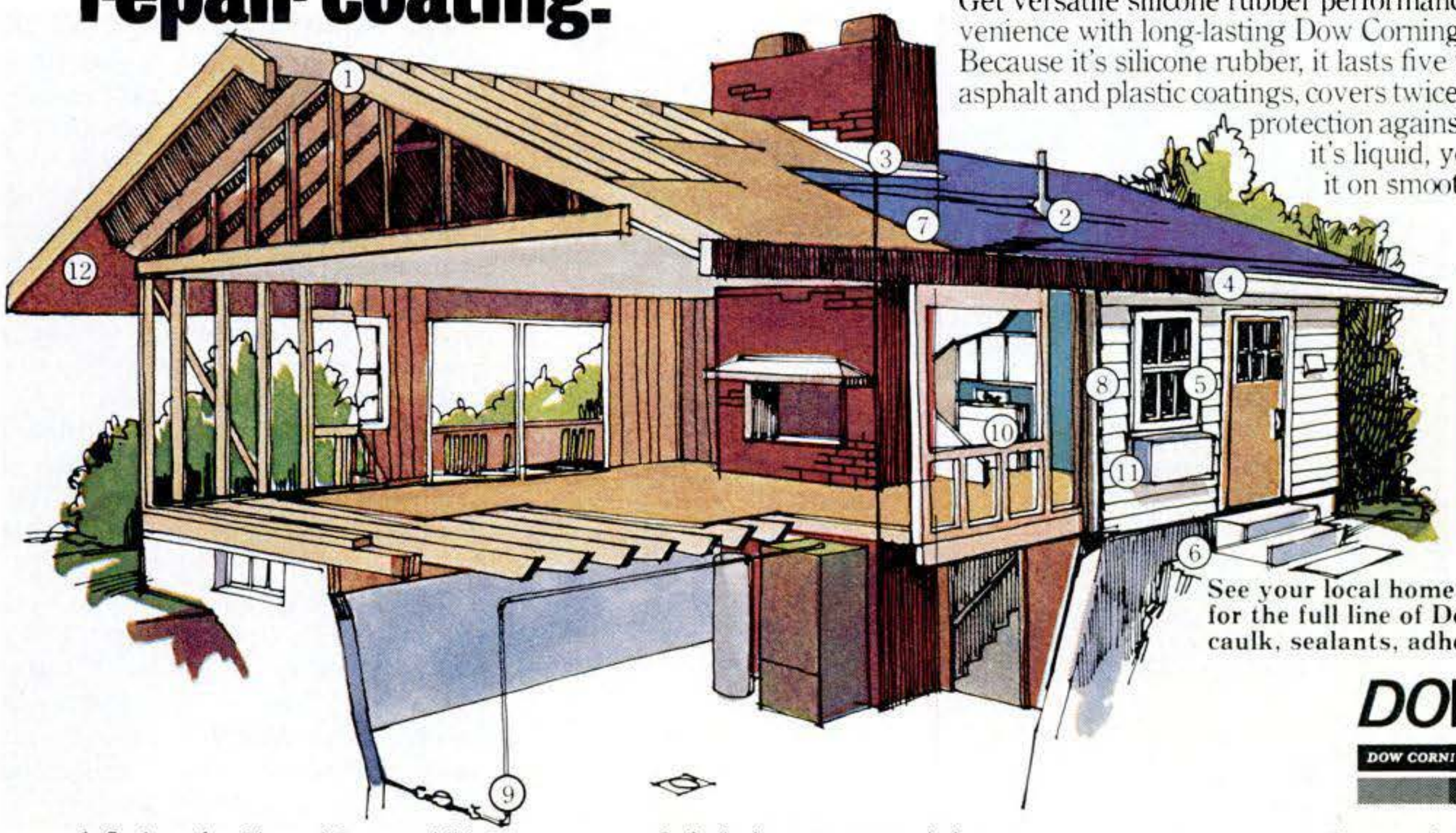

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[Continued from page 112]

second—that the human eye sees only systems that apparently are getting power full-time. On the first four B-1's, 29 subsystems, including lighting, landing gear, all avionics, engine thrust, and all engine instruments and wing-sweep, are on EMUX. And the system, built for Rockwell by the Harris Corp., is still being improved.

In addition, many circuit breakers and switches (which are not a part of the EMUX system) are being replaced by solid-state controllers—small electronic cards—instead of electromechanical devices. That will reduce the B-1's weight by another 100 pounds.

"You won't see this system on a commercial jet for a while," EMUX manager Ray Froman told me. "Commercial designers are conservative. But it's such a weight-saver that it has to come. It means more seat-miles, more cargo capacity."

That's what EMUX did for the B-1. After the electronics experts won heated debates and got the go-ahead to design it into the aircraft, it not only saved weight—about 1200 pounds, the equivalent of 57 miles of wire—but also cut several thousand hours off the manufacturing process by reducing electrical installation time.

Inquiries about the system are starting to come in now. Rockwell's own business-jet designers are looking at electrical multiplexing, and some EMUX techniques have been adapted to the Space Shuttle.

The Shuttle also benefited from diffusion bonding developed for the B-1. In that process, titanium or its alloys are heated in a vacuum. Under high pressure from a press, two pieces of metal diffuse into each other to become a single shaped component. Structural elements that once required welding or extensive milling, such as the B-1's fuselage frames and support beams, now are formed by diffusion bonding. The components are stronger and less expensive. With the procedure proved in practice, Shuttle designers readily adapted it for the Orbiter thrust structure.

More of the B-1 technology story will be told in years to come. But the message today is plain: Whatever the B-1's fate as an operational bomber, the research and development that went into it produced a giant leap ahead in technology—one that will profoundly affect all future aircraft, and have a lot of down-to-earth applications as well. PS

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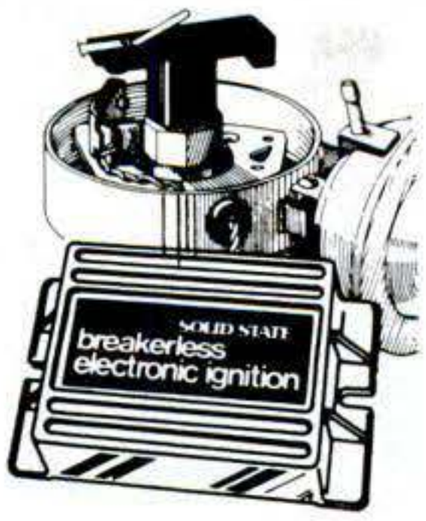

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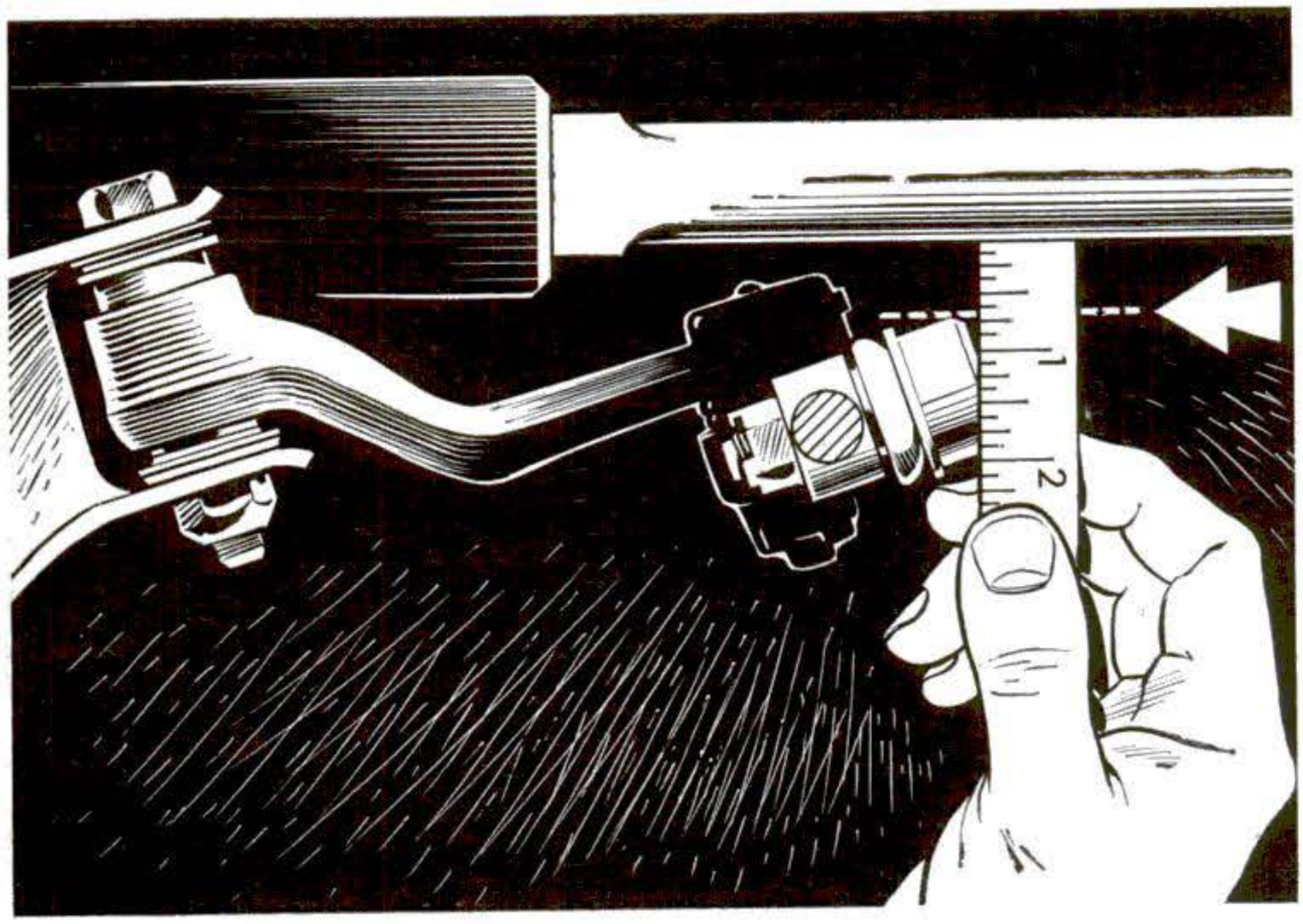
TAKING CARE OF YOUR CAR

By RICH CEPPOS

Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you $25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.



Diagnosing mysterious front-end problems

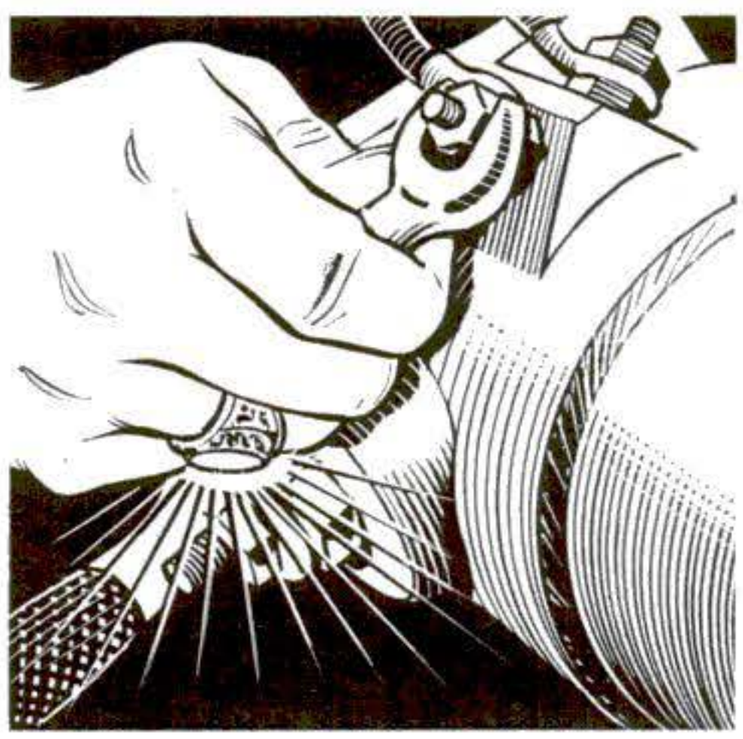
If your Chrysler car has a tendency to wander over wavy surfaces, yet toe-in, caster, and camber all check out, there's a test you can perform that might indicate where the problem lies. With the car on a hoist or pit, turn the front wheels until the inner tie-rod sockets are directly below their respective torsion bars. Measure the tie-rod socket-torsion bar clearance. If the difference between the left and right sides exceeds ½ inch, your problem is caused by the difference in tie-rod heights, and this must be adjusted.

Watch that rustproofing

When applying rustproofing to door panels, be careful not to coat the remote-control mirror cable. It will cause the cable to bind, preventing mirror adjustment. If you coat it by accident, soak it in mineral spirits and light oil for 15 minutes.

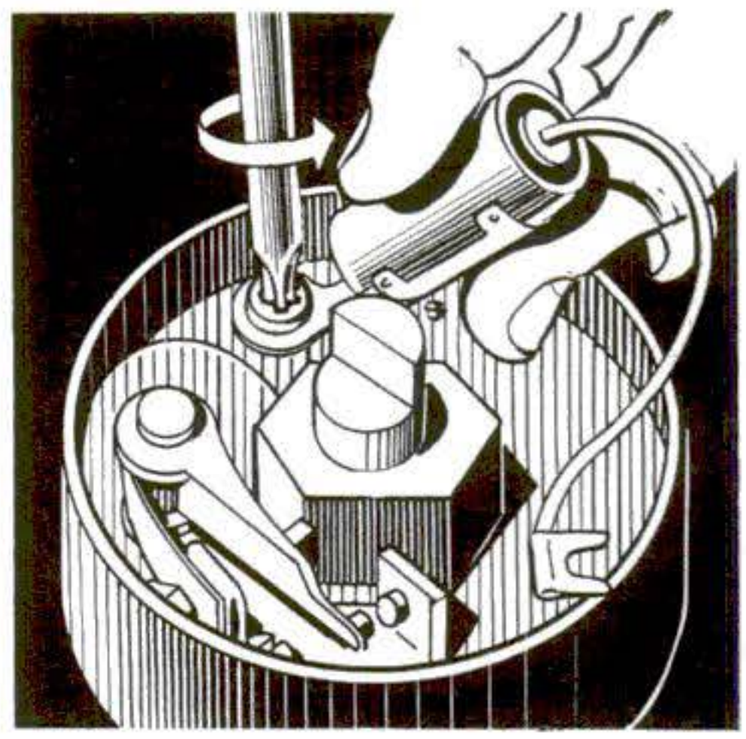
Don't remove that kink

Don't straighten the kink in the flexible hose that runs from the cold-air inlet duct to the air cleaner on Chrysler cars equipped with the 225-cu.-in. slant-six engine. It might seem logical to route the hose in a straight line, but if you do, it will rub on the choke mechanism, preventing full engagement and causing hard cold-starting. Forcing the air cleaner into a new position might damage it, too.



Take off those rings

Never work on or around the starter motor or solenoid with rings or other jewelry on. Your rings or wristwatch can easily cause a short, with painful results: A ring will become red-hot almost immediately and severely burn your finger. It's a good idea to remove your rings whenever you work on any part of the car. They can easily become encrusted with dirt and oil, scratched, or be caught on parts.



Removing condensers

Condensers on some Fords are difficult to remove because the condenser hold-down screw gets stuck. Even with a good screwdriver you can strip the head or damage the advance plate. To loosen the screw, disconnect the condenser wire and bend the condenser up off its locating pin. Get a firm grip on the condenser and twist it counterclockwise while trying to loosen the screw. The screw should come out easily.

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Tough Test #3.

Push a Hot Button and 240 overhead heat lamps put us right in the middle of the Sahara Desert. In this 110-degree oven, we test the engine cooling system, air-conditioning, ventilation.

Tests like these are tough on a car. But tough testing makes for tough cars...so, at Ford Motor Company, we do a lot of it.

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HOUSEPOWER CLINIC

By EVAN POWELL

Check that washer drain

One of the simplest parts of an automatic washer—the common drain pipe that carries the water from the pump to the standpipe in your home—can be a big troublemaker.

When the standpipe that the crook of the washer drain rests in isn't high enough, a baffling problem occurs: In some machines, the water will siphon from the tub while the machine is agitating. After a few minutes it stops and fills back up; but it doesn't necessarily do it *every* time, only when the line remains full of water from the last pumpout. The solution is to raise the standpipe to a minimum height of 34 inches.

The same problem can exist when a length of drain pipe is placed on the end of the normal crook or "gooseneck" of the drain line and extends too far down into the standpipe, or when the standpipe is sealed at the top as a makeshift remedy for an overflowing drain.

Another problem arises when the drain line is too long and lies looped behind the washer. It may work for a year or two, but finally regular heating and aging allows it to crimp. Many washer drain lines are made in two sections or with a detachable crook so they can be tailored to the exact length needed.

The most serious drain problem is caused by a drain line that's too long—usually not long enough to crimp but long enough to allow water pressure to lift the line from the standpipe. When this happens, water pumps onto the floor rather than into the standpipe. Many heavy-duty washers hold more than 20 gallons, and when that's spread over a floor, you've got a lake!

To eliminate these problems, refit the line to the exact length needed and/or tape it to one of the supply hoses.

Through-the-sink disposer

That's not a chrome salami you see going through the sink opening in this photograph; it's Whirlpool's new economy-model disposer (SDD 4000). The size itself is an advantage—it weighs only 6¼ pounds and takes up little storage room under the sink, but the big news is for do-it-yourself installers. A one-piece sink flange is formed in the disposer's upper chamber; after it's lowered through the sink, it simply locks in place with a snap-ring and set screw, leaving both your hands free for the plumbing and electrical hookups. A saddle-clamp adapter is used to make the connection to the drain

line. A universal motor provides a high continuous speed action (up to 11,000 rpm)—not heavy-duty, but adequate for normal use.

Off-peak-power pricing

When PS first told you about the pros and cons of selective pricing of residential electrical power [PS, July '75], the concept was in its infancy, being tried experimentally in a few areas. Now it's blossoming out all over: Many power companies plan such rate schedules in the near future.

I have been watching this progress closely, and I am experimenting with some "load-shedding" concepts, which can automatically take advantage of off-peak rates. If all goes well, PS will have a future report on the subject.

In the meantime, many Housepower Clinic readers are likely being served by two-rate programs at this time. I would like to hear your views about the system being used in your area and what you are doing to take full advantage of it. Include information about your type of system (timer-initiated or ripple-current-initiated) and whether it operates on the two-rate or demand concept. You'll find my address at the end of the Clinic.

Q&A Washer flow control

While cleaning the two strainers on the inlet valve of my Norge 231-261-0 washing machine, I let a brass washer with a quarter-inch hole and a "dished" rubber washer fall out of a small recess in the valve. Now I can't figure out their proper position in the valve. And the machine seems to fill too high, now. I don't have an address for Norge.

Robert Dezendorf, Oceanside, N.Y.

That dished rubber washer is a type of flow control often used with washers that use a timed fill cycle. It acts as a regulator: As water pressure increases against the orifice, the opening constricts to reduce the flow volume. The dished side of the rubber flow washer should go against the brass washer (pressure plate), and should be installed so water first flows through the rubber washer and out the brass one. You can write to Norge Co. (now a division of Fedders Corp.), Herrin, Ill. 62948.

Conserving hot water

Is it advisable to turn the water heater on only once in each 24-hour period? For instance, I could turn the heater on in the late afternoon to bring the water up to my thermostat setting (125°), then turn it off, wash clothes, dishes, and take shipboard showers till the water is cool, then leave the heater turned off until the following afternoon.

B. G. Myking, Hendersonville, N.C.

You would probably notice a difference in your water-heating bills, but this would likely be a result of your emphasis on hot-water-saving practices rather than the on-off program. The only energy reduction comes in that portion used to replace heat lost through the insulation. That's negligible on a well-designed heater. If yours becomes more than slightly warm to the touch, an insulation wrap would be a better investment than a timer.

It's a different story if you are in an area with two-rate electric-power pricing, however. In this case, a timer can be used to good advantage to let you take advantage of the lower off-peak rates. If you program the timer properly, you'll likely never notice the difference in availability of hot water.

Cracking fireplace

I have a fireplace air-heating unit that is twenty years old. It has a couple of cracks in the rear wall of the corrugated cast-iron firebox. Is there a furnace cement that will seal these?

J. C. Cordner, Yachats, Ore.

Furnace cement is only a temporary cure for a problem like this. If the unit is cast iron, it could be brazed—but you'll probably find that the cracks continue to develop, and the only sure cure will be to replace it.

Most present-day prefab fireplaces are steel, and some manufacturers make mending plates that can be welded in place on the rare occasions when a crack develops. For recommended repair procedures, write to the manufacturer. PS

Got a problem?

Looking for an answer to your home-equipment problems? Write Evan Powell, Housepower, 108 Morningdale Drive, Greenville, S.C. 29609, giving make and model number. Sorry, but questions can't be answered by mail.

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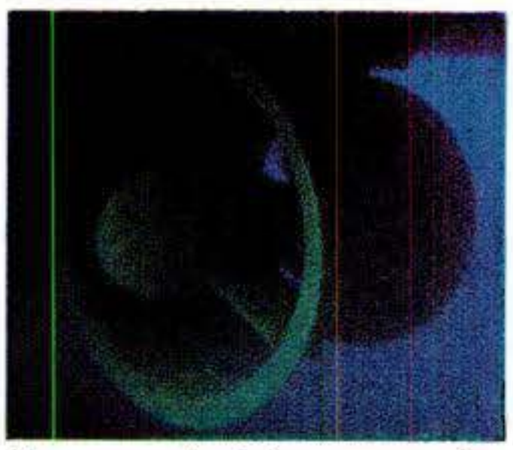
Over two-thirds of the earth's surface is covered by ocean. Unfortunately, so are some of the world's largest oil deposits.

For years, shallow water drilling platforms were used to recover a small fraction of this oil. But billions of barrels buried deep at sea were still beyond man's technological reach.

Soon special drilling ships were developed to operate in deeper and deeper waters. Except these ships depended on anchors to hold themselves in place over the drilling site. And in many instances, oil was buried beneath waters so deep, even anchors couldn't help.

Discoverer Seven Seas

Then the people of Phillips Petroleum joined together with an international group of companies to put a different kind of drilling ship into operation. Discoverer Seven Seas. A drilling ship so uniquely capable, it can drill for oil in depths never before thought possible. As great as 6,000 feet below the surface. Instead of relying on anchors, this remarkable ship uses a system of computerized underwater thrusters to keep it in place.



Computerized thrusters take the place of anchors.

Dynamic positioning is the key

Once Discoverer Seven Seas starts to drill for oil, information about the exact location of the drilling hole is beamed directly from the ocean floor to computers on board, through sensors in the hull of the ship.

From that point on, it is virtually locked into position. Every time wind, waves or ocean currents push the ship off target, the computer-activated underwater thrusters automatically push it back on track.

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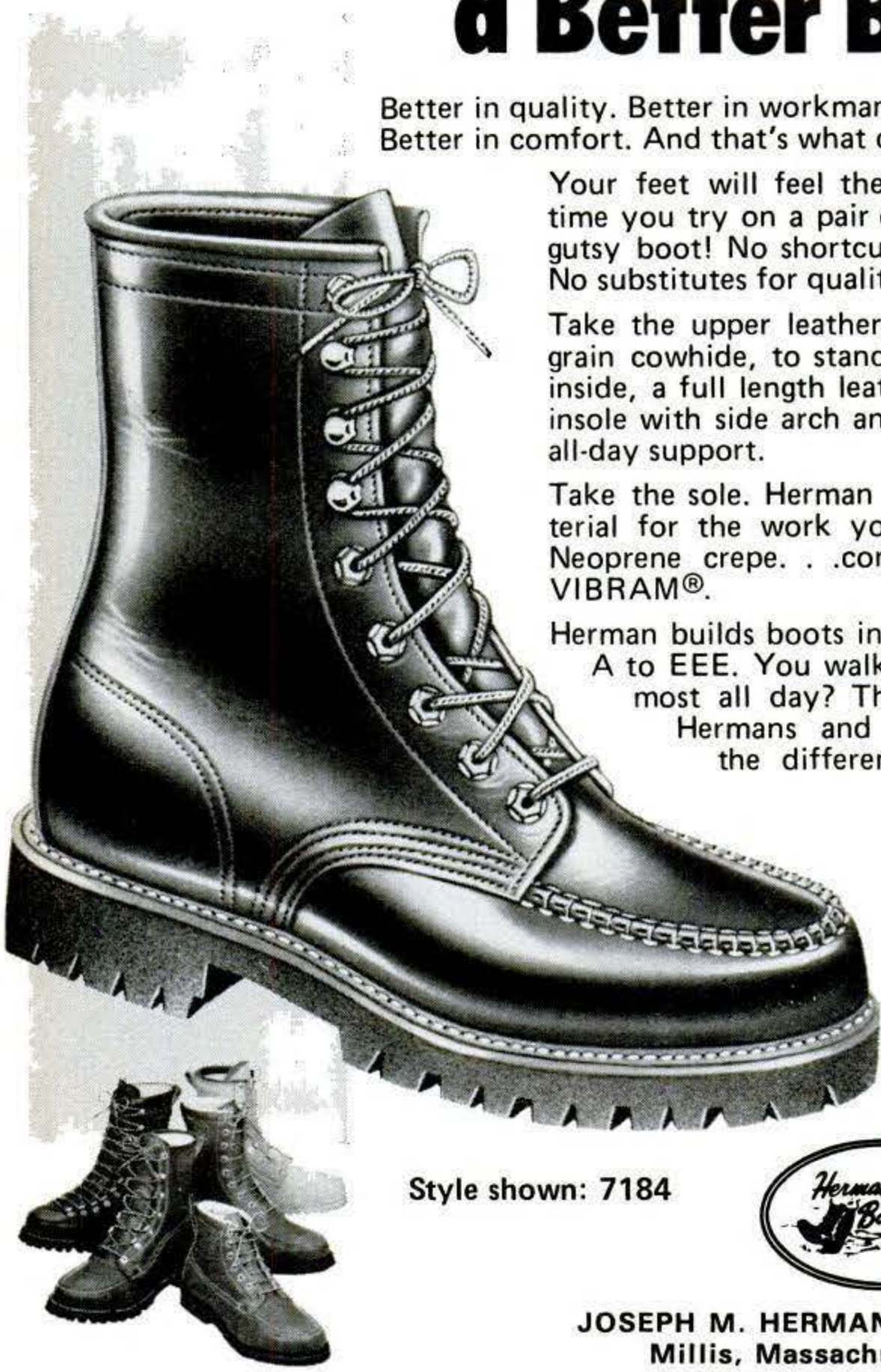

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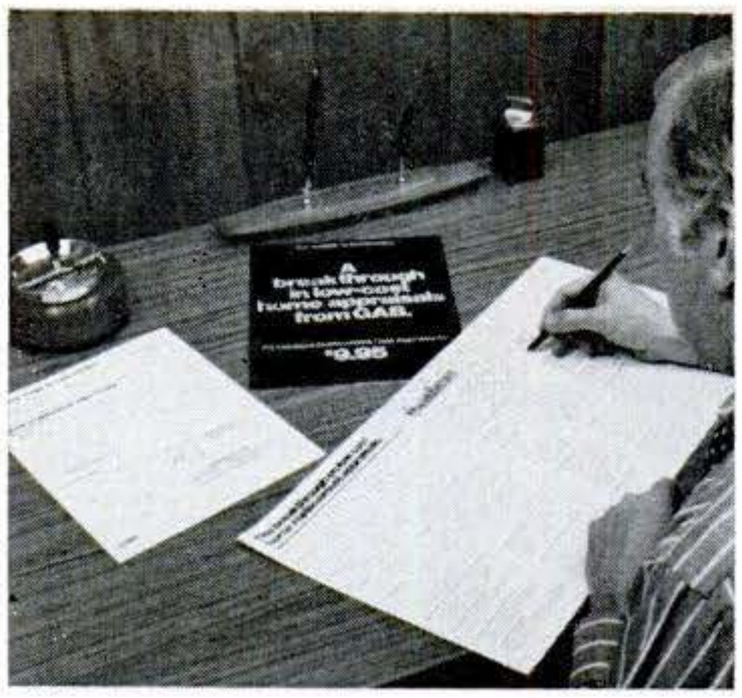

Computer appraises your home

A typical on-site home appraisal can cost as much as $200. A new service, known as Value Rater, will figure the replacement cost of your home, and send you the computerized evaluation and appraisal certificate by mail within 10 days. The charge: $9.95.

The service, recently announced by GAB Business Services, is available nationwide for residential property valued at less than $125,000. It's made possible by the computerization of locally derived variables such as type of construction, regional variations in labor and materials costs, and building standards.

The one-page form for Value Rater is completed by the homeowner and mailed to GAB's Princeton, N.J., appraisal center. No appraisers visit your home. GAB says that its system takes into account such specific elements as type and extent of foundation, exterior covering, quality of windows and roofing, floor and wall construction, style of fireplace (if any), floor coverings, air conditioning, and electrical, plumbing, and heating systems.

The system uses real labor and materials costs from 480 selected locations in postal zip-code areas nationwide.

The appraisal certificate, says GAB, can help you determine whether you have sufficient insurance on your home. A $30,000 home in 1965 would cost upwards of $55,000 to replace today; building costs have risen at a rate of six to 10 percent per year.

GAB is not an insurance company or agent, but an independent service that's part of the corporate family that owns United Airlines and Western International Hotels. The address: GAB, 1101 State Rd., Princeton, N.J. 08540.—*N. Smith*

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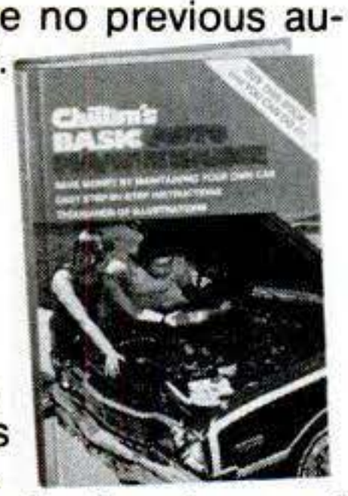

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[Continued from page 83]

techniques involving high pressure: fire-flooding and steam injection."

Fire-flooding is just that. You dig a well, pump in air, and flood it with fire. Close to the fire, the heat cracks the bitumen into coke and distillates. Farther from the fire, the heat thins the bitumen. The distillates mix with the thinned bitumen, thinning it even more—enough to be pumped out through collection wells nearby. The coke burns to continue the process. Amoco, among others, has worked on fire-flooding for 20 years. With government backing, it has recently started on a large-scale, $69-million pilot program.

Huffing and puffing

Even more promising is steam injection. Here, you pump high-pressure steam into a bunch of closely spaced wells, let it sit a month, then pump out whatever you find. At first you get bitumen mixed with hot water and steam, then bitumen mixed with just hot water, and then just plain hot water. When that happens you blow in more steam to begin the process again. "Huff-'n'-puff" they call it.

"A number of outfits have been developing that," Flock told me, "but Imperial (Exxon) is in the lead. For years it's been working on a pilot plant out in Cold Lake, Alberta. I wouldn't be surprised to see it expand to a Syncrude-size operation even before the next surface plant is built."

Gain versus gamble

However, that may not be for a long time. When I began investigating the field, Shell and a group led by Petrofina were planning to build the next two surface plants. But shortly before I flew out here, both firms canceled the project. I asked J. E. Baugh, senior vice president of Petrofina, why. His answer was a litany of rising costs, uncertain oil prices, high taxes, and distasteful regulations. "All these," he said, in effect, "make the gain not worth the gamble."

Steam injection sounds simpler and cheaper, but a Syncrude-size operation would need thousands of wells and gargantuan steam generators. The economics would probably be about the same as for Petrofina's surface project. Baugh summed it up: "We think the thing is financeable," he told me, "at close to zero taxes and royalties."

Seven-year development

A government might eventually agree to this, since much of Alberta's economy is based on oil, and Canada is running short. But even if terms were worked out right away and the oil companies rushed in, a Syncrude takes five to seven years to design and build. In a province the size of Texas with only 1.6-million inhabitants, it's hard to find a spare 10,000 electricians, pipefitters, or engineers—especially when most of the jobs are in a frigid wilderness at least 250 miles from the nearest city. And with a population that small, an extra half-billion dollars a year in construction money is hard for the economy to digest. Physically and financially, it would be difficult to build more than one Syncrude at a time. Yet we'd need a new one every year just to keep up with Canada's own increase in demand. PS

Rockwell faucets. So simple to install...

Right! Rockwell single control faucets for your kitchen or lavatory are so simple to install a twelve-year old can do it. And the twelve-year old young lady you see here has done just that. So have other twelve-year olds. We'll send you their names on request.

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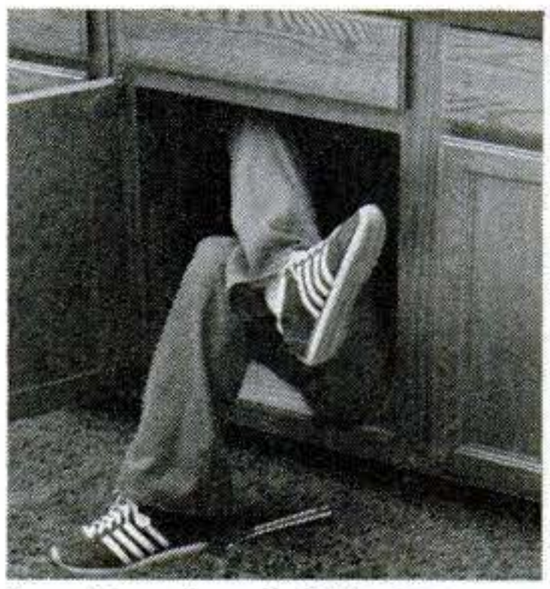

too, there's a full 5-year warranty for "Drip Free" performance.

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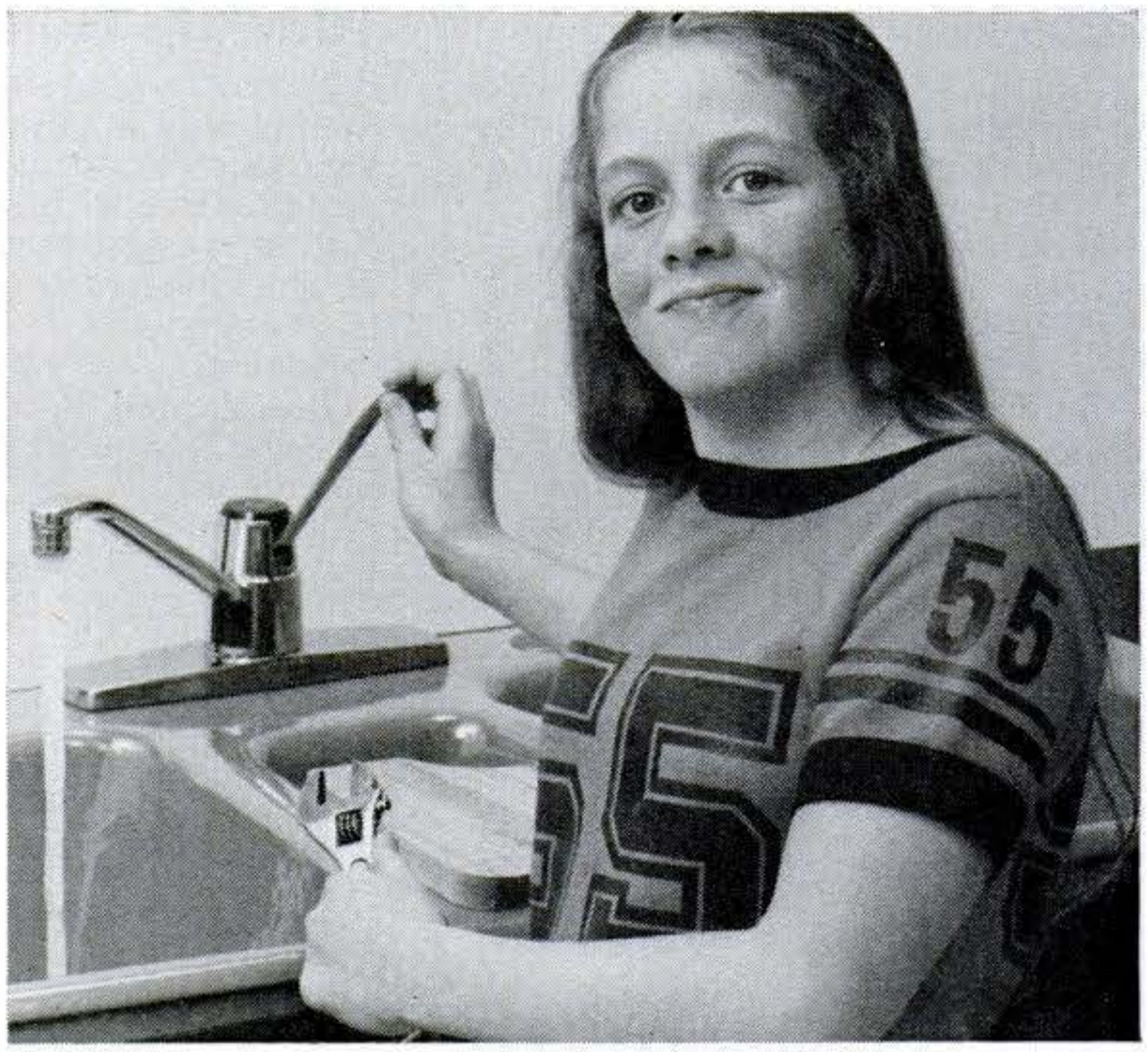

a twelve year-old can do it.

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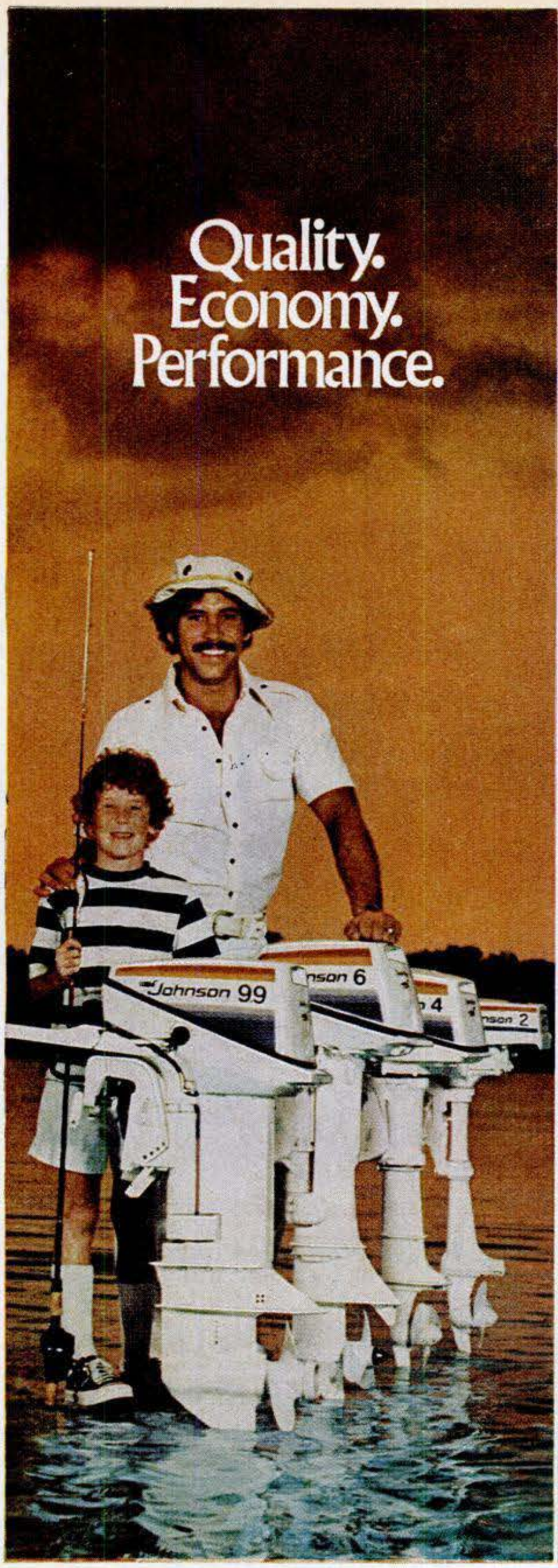

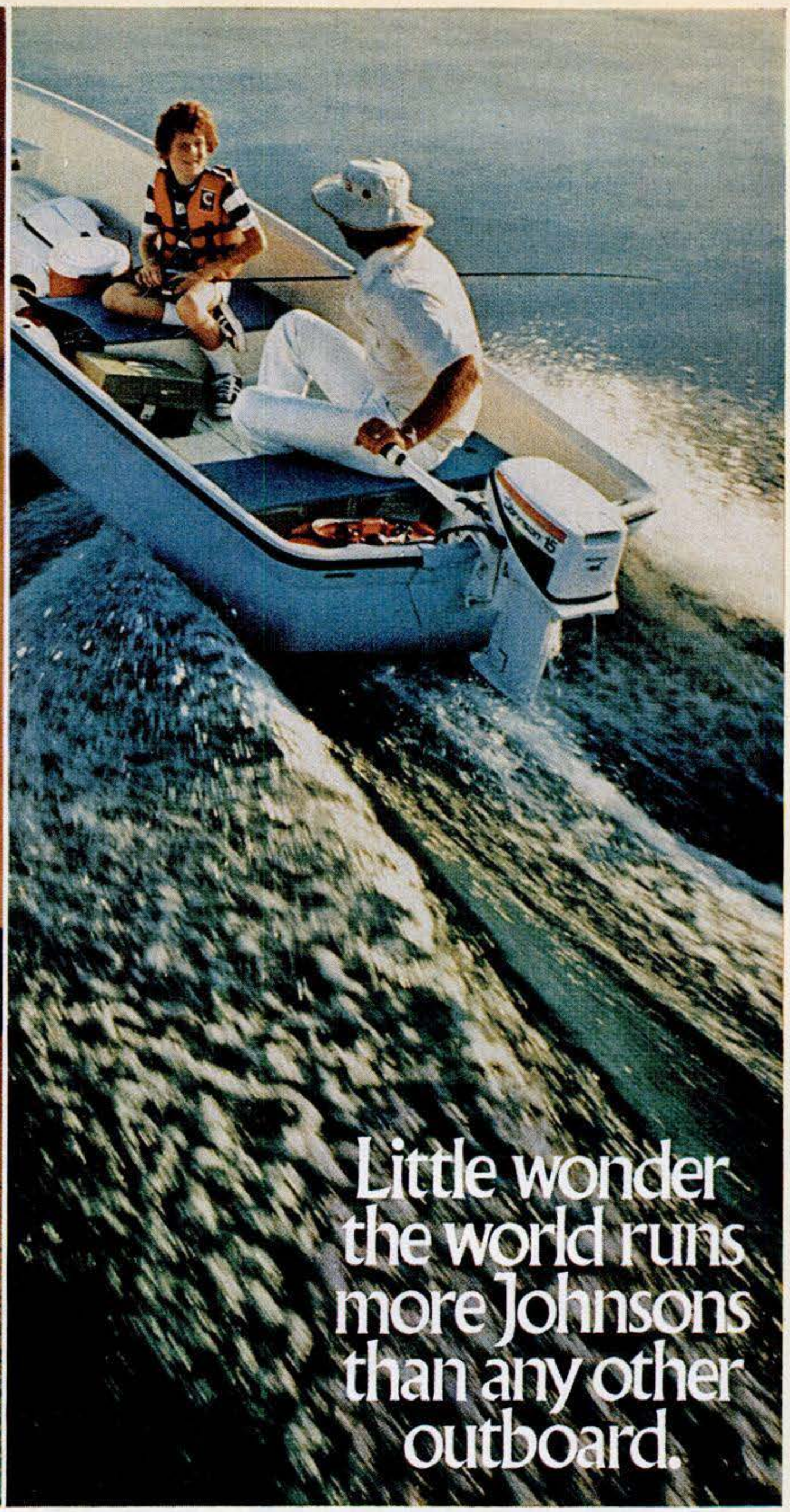

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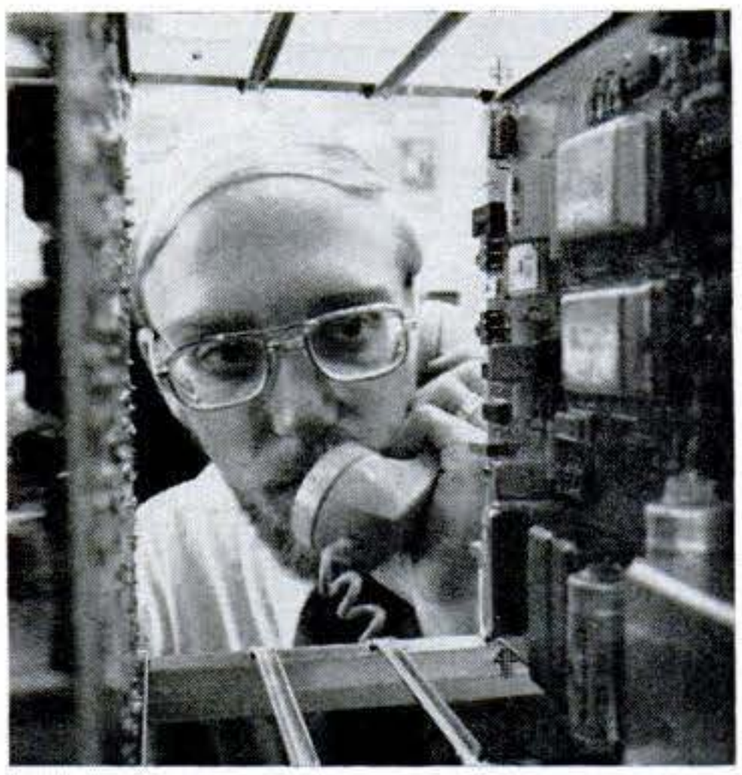
Tiny patterns etched on this garnet slice are avenues for bubble movement. More than three million bits of information are stored here.



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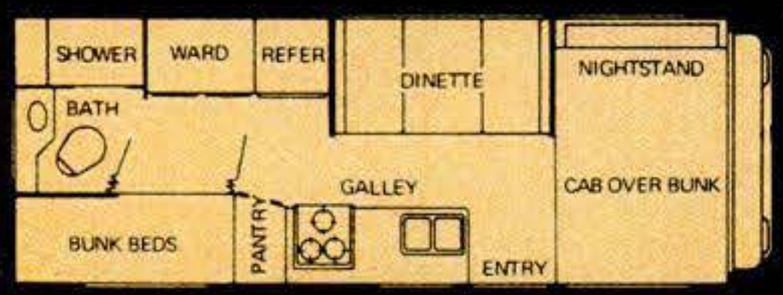

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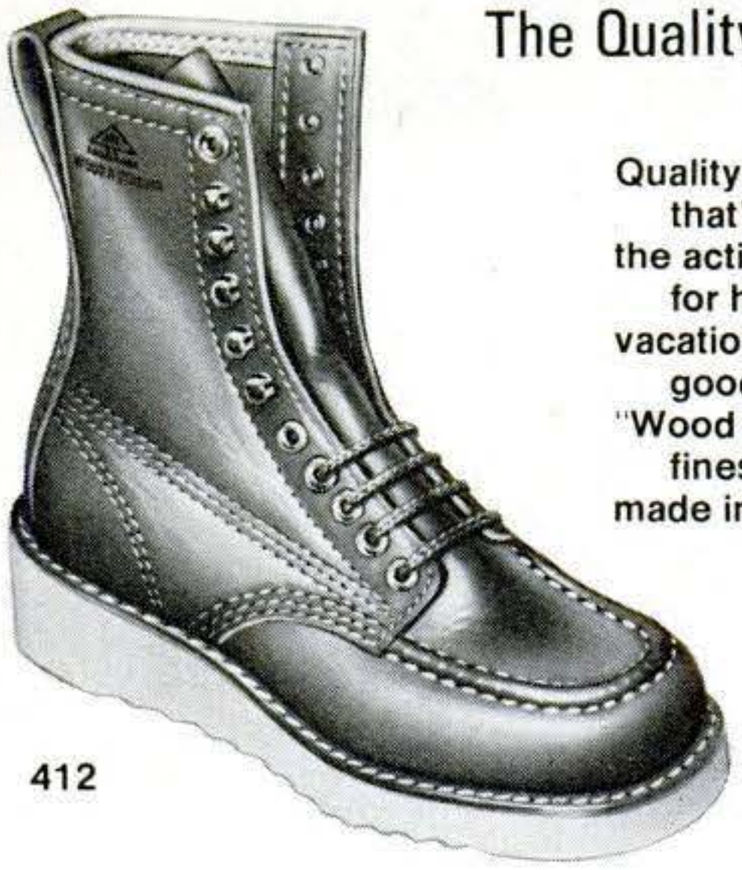

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Timing light

[Continued from page 124]

ual to see whether it should also be turned on.

Start the engine. Now aim the timing light toward the timing marks. Be sure your hands and clothing are clear of the fan and belts. When illuminated by the timing light the fan may appear to be stopped—but never forget the engine is running.

If the timing is correct, your two chalk marks will line up. If they do, shut the engine off and tighten the distributor hold-down. If they don't, rotate the distributor until the marks line up. Stop rotation, shut off the engine, and tighten the distributor hold-down. Restart the engine and recheck the timing marks to make sure you didn't shift the distributor during the tightening. Then shut off the engine and reconnect any vacuum lines disconnected earlier. Reset idle speed at spec.

Centrifugal and vacuum advance

The timing light can also be used to tell if centrifugal and vacuum advances are working. It doesn't give you an accurate reading, but it will tell you if either isn't working—which usually is all you need to know.

To check centrifugal advance, disconnect and plug the vacuum line to the distributor. Have someone step on the gas pedal, or increase rpm by moving the throttle linkage yourself—and watch the timing marks. If the reference mark moves to the advance side of the timing scale, the centrifugal advance is working.

To check vacuum advance, connect vacuum line to distributor with the engine running. On most cars, there should be no change in timing at idle after the line is connected. On some, the spark may actually retard. Check specs for your make and model. When you increase engine speed, the spark advance should be greater than it was with the line disconnected. PS

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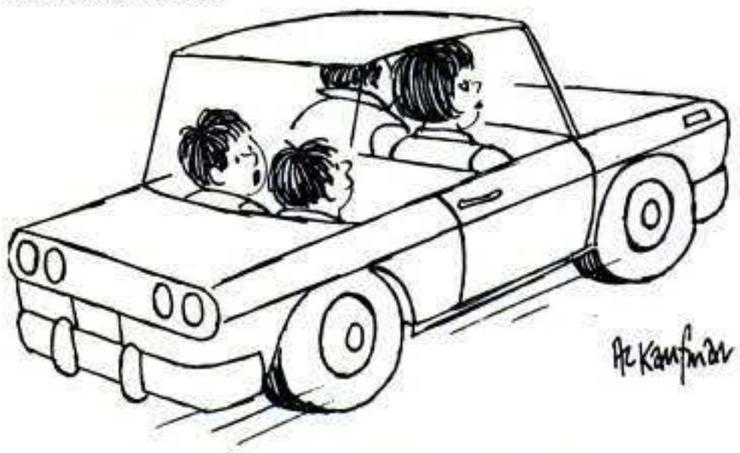

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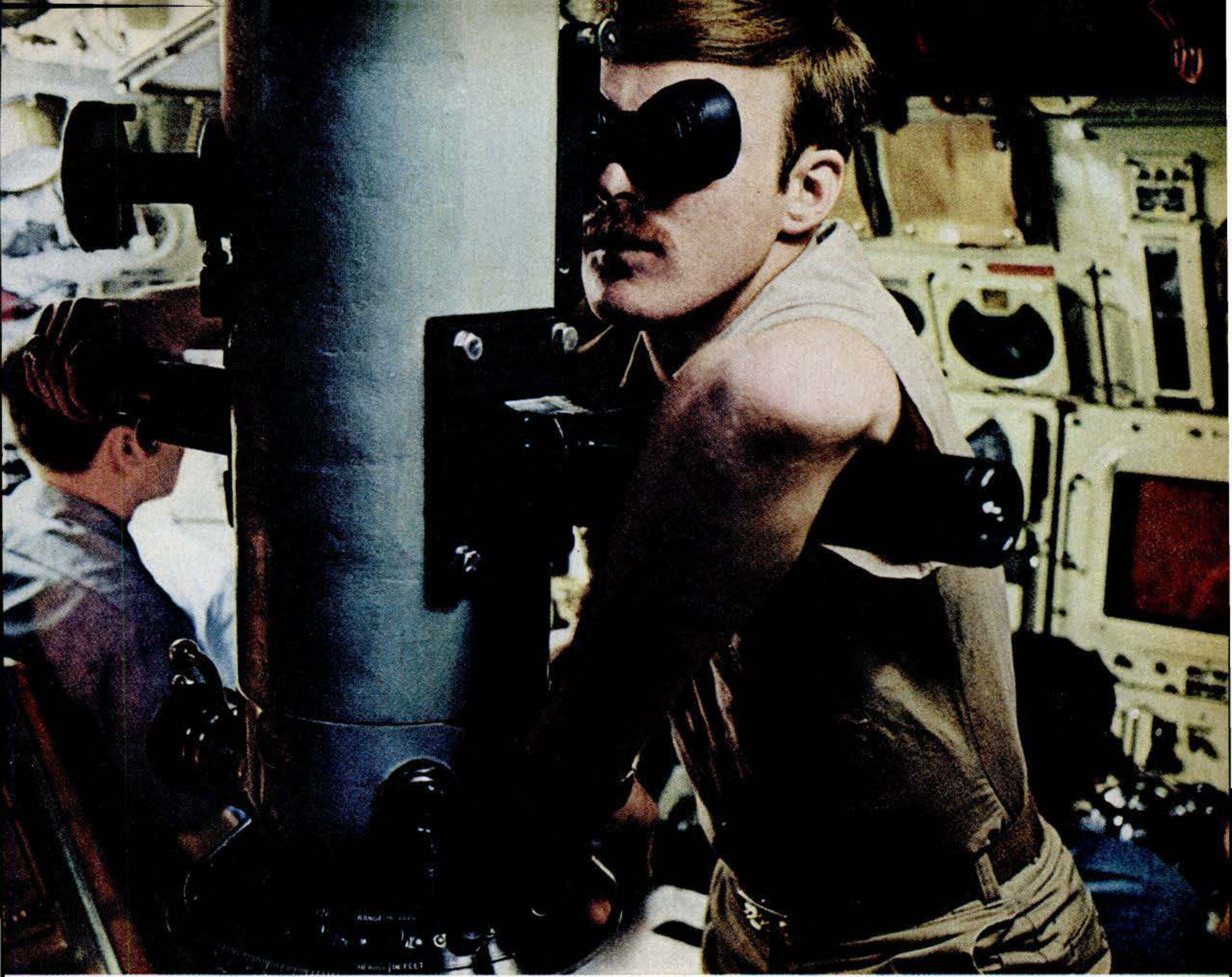

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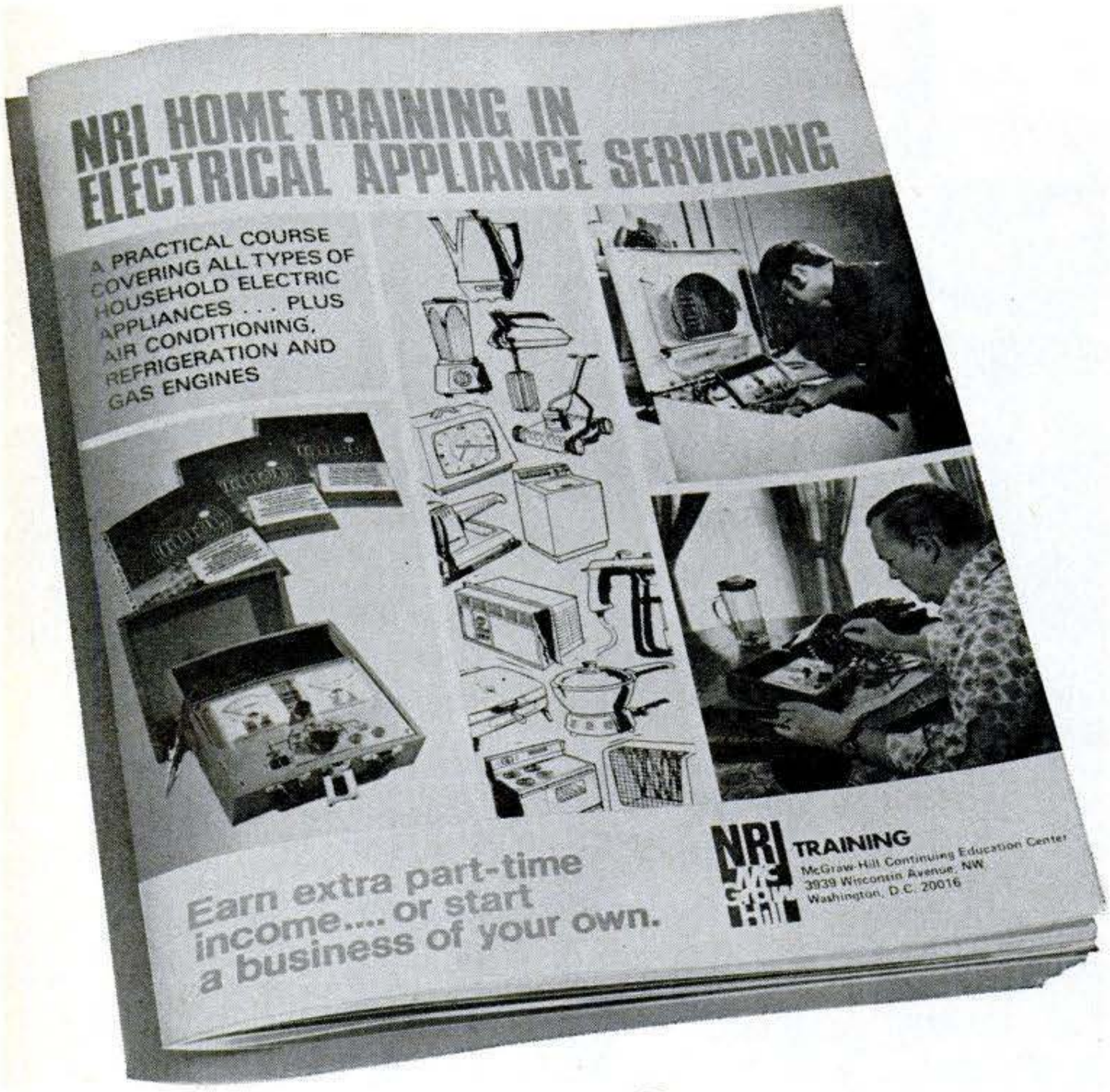

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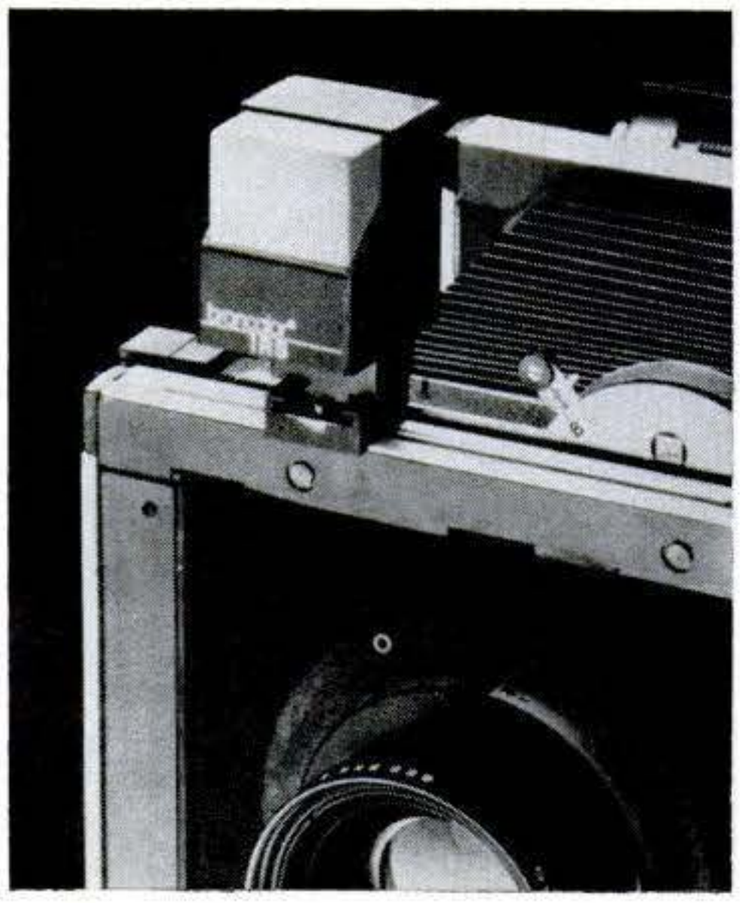
The nuisance and clutter of synch cables to connect camera and electronic-flash units in studio use are eliminated in the new Broncolor IR system. Two units, each slightly larger than a matchbox, replace the cables: a transmitter at the camera that sends out an infrared light pulse, and a receiver at the power pack of an electronic-flash unit.

The light pulse, reflected from walls and ceilings of a studio, pervades the working space, enabling the photographer to position his camera anywhere, or even to hand-hold it and move around without tripping over cables. The 2½-ounce transmitter, shown above on a 35mm camera, and below on a view camera, is $124. The receiver is $171.70.

The system is distributed by EPOI/PPD, 101 Crossways Park West, Woodbury, N.Y. 11797.—*Everett H. Ortner*



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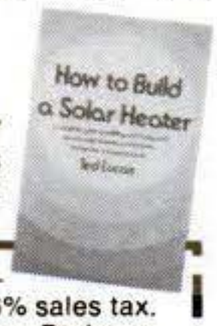

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Clock/ thermometer

sounds time and temperature alarms

Temperature readout (top) alternates between indoor and outdoor sensor probes. Back panel of $125 Heathkit ID-1490 bristles with switches.

A *beep-beep-beep* sound from Heath's ID-1490 can wake you up—or alert you that your water pipes are about to freeze up. The new kit clock/thermometer operates as a digital-readout alarm clock, displays inside and outside temperatures, and sounds a temperature alarm.

I built a 1490 in about 11 hours and spent another hour calibrating the thermometer circuitry. Heath supplies an accurate thermometer to calibrate the indoor and outdoor sensor probes.

Once adjusted, the thermometer section can be set with rear-panel switches to alternately display indoor and outdoor temperatures (in Fahrenheit or Celsius), or constantly display only one temperature-probe reading. An alarm-adjust control can be preset within a −40° to +160° range for the outdoor probe, which triggers an alarm for temperatures above or below the setting. Other features: a switch for 24-hour time (18:00 for 6 p.m.), three levels of display intensity, plus touch plates for the alarm and 10-minute-snooze functions.

One caution: The probes can easily be plugged in upside down, giving you constant −40° temperature readings. I mistook my error as a circuit malfunction.—*John Free*

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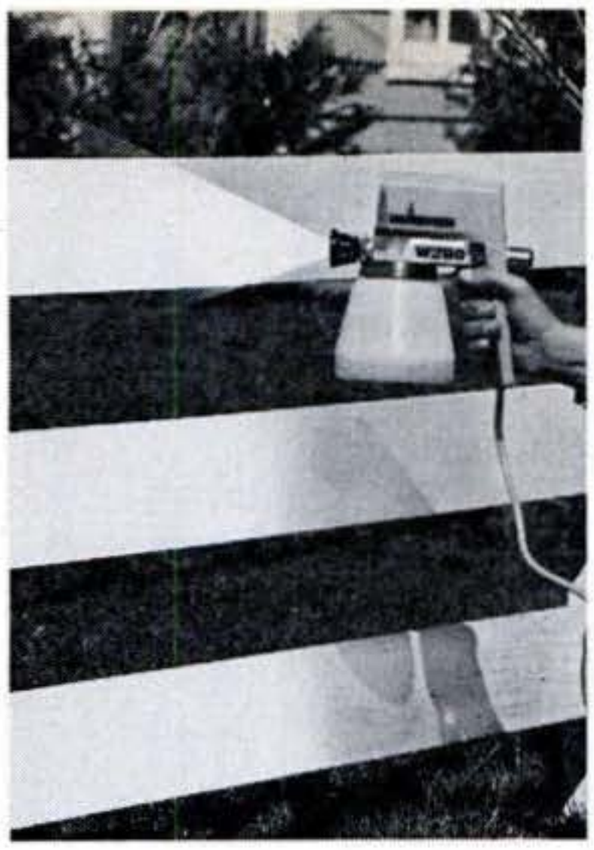

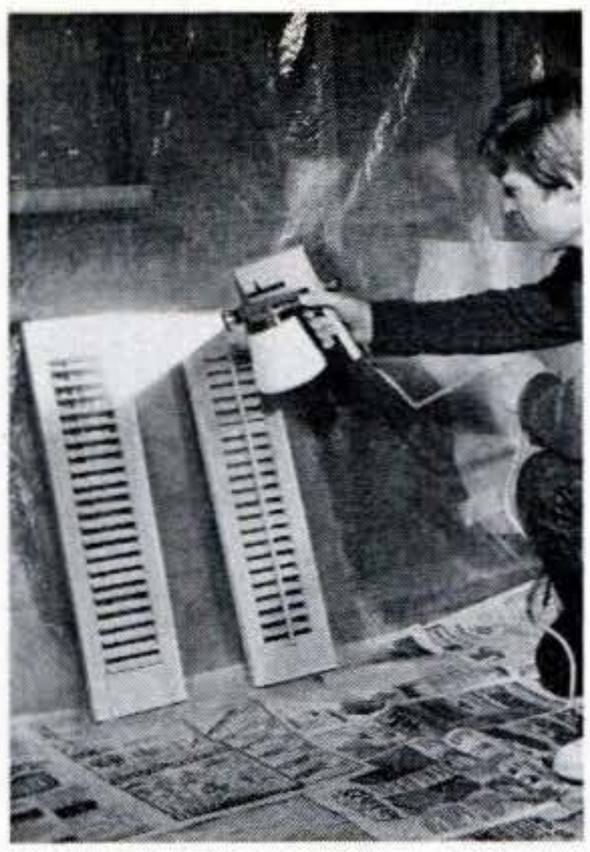

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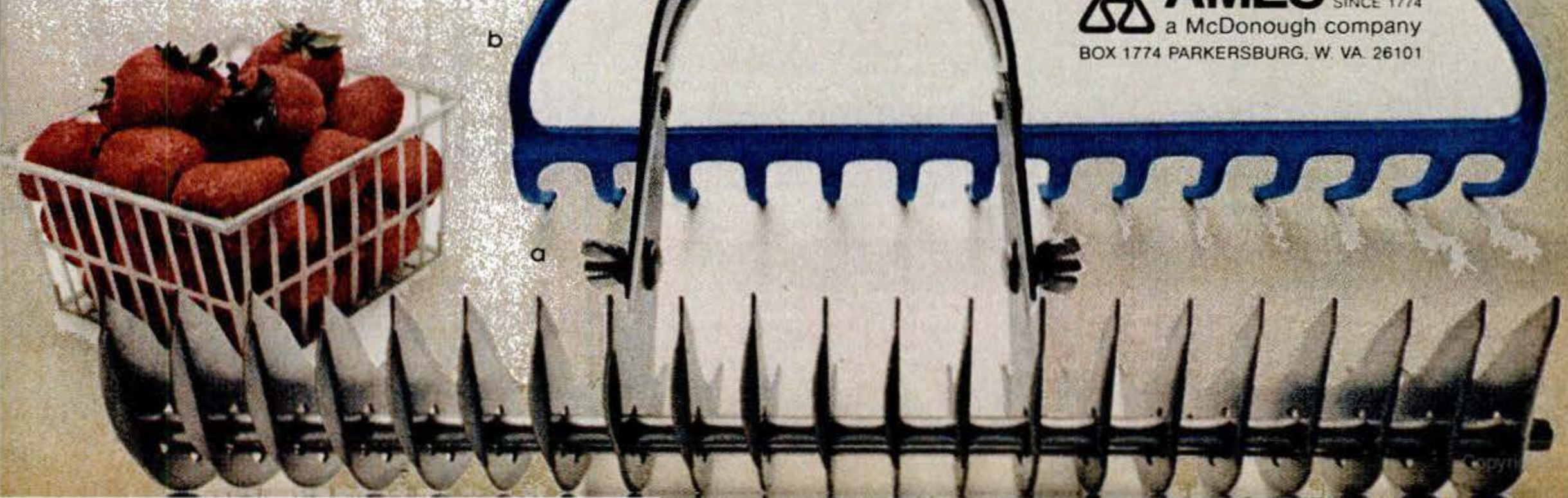

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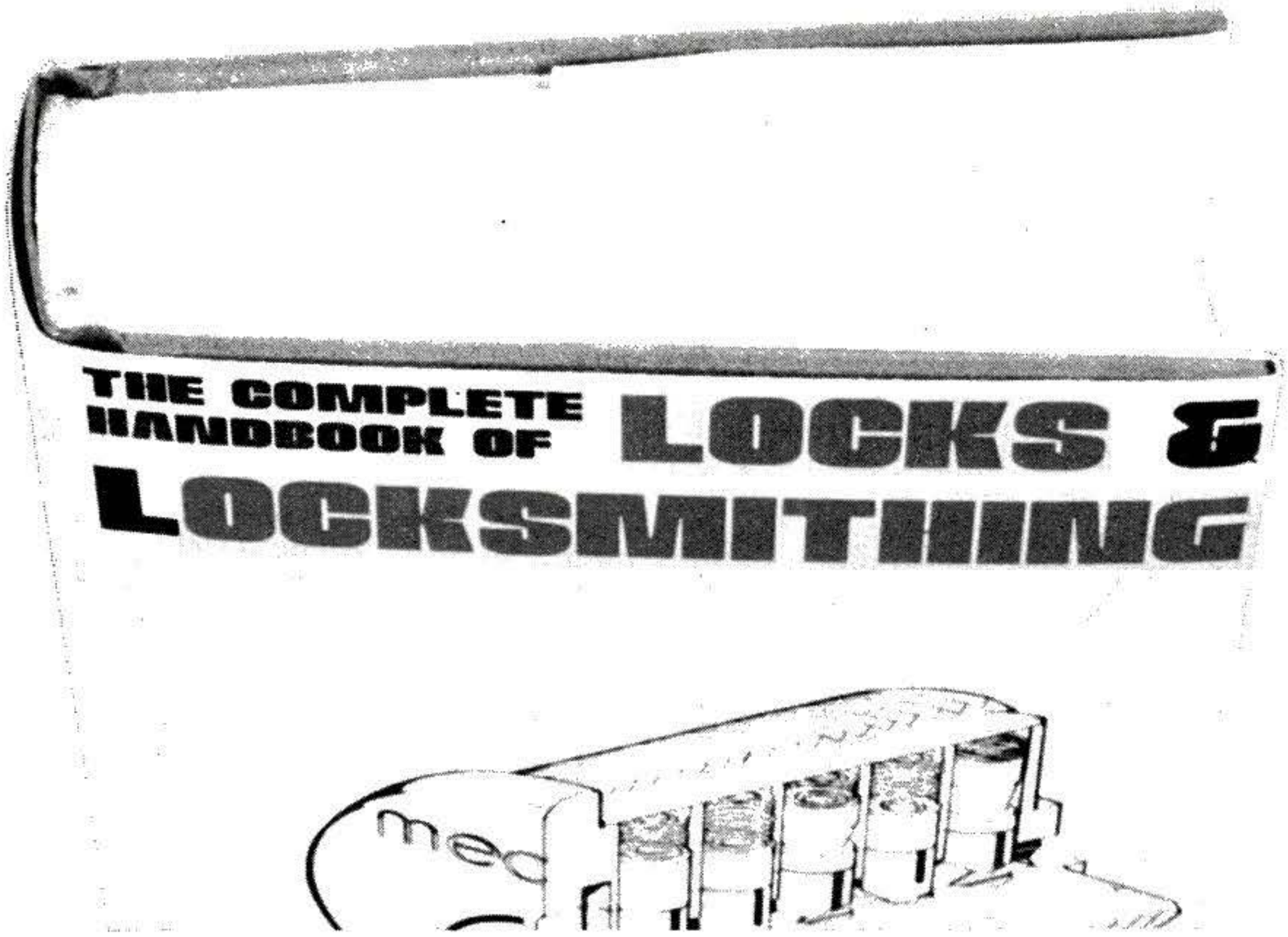

The Complete Handbook of Locks and Locksmithing

This brand-new and extremely comprehensive volume is a detailed lock-by-lock course in the craft of locksmithing. It's written especially for beginners, and it teaches you step by step all the skilled, practical know-how of the professional locksmith. It starts with the basics, and it covers the whole field of locksmithing, from the simplest to the most sophisticated high-security protection devices. You learn how to cut keys, how to decode lock codes, how to masterkey, how to extract broken keys, how to change lock combinations, how to repair lock mechanisms, how to convert everyday locks to more protective ones, and how to open locks...even how to start your own locksmithing business. This interesting volume covers every kind of lock in current use—from the inside out. There is practical, ready-to-use information on combination locks, lever locks, vending machine locks, disc-tumbler locks, cylinder locks, automobile locks (ignition, door, trunk, glove compartment, gas tank), warded locks, padlocks, and many, many others. Even if you've never seen the inside of a lock before, this plain-talk handbook will show you how to repair, service, and install just about any lock you'll ever come across! You'll learn how every component works—every spring, every ward, every pin, every key...plus all the proven, reliable locksmithing techniques the pros use.

At last, here's an easy-to-understand guidebook that shows the rank beginner how to handle locksmithing tools with all the skill of the trained locksmith. There are complete instructions on how to use files, key machines, lockpicks, extractors...all the tools of the trade.

To truly understand locks, you really have to "get inside" them, so there are over 200 cutaway and exploded-view drawings and photographs to help you do just that. These clear, revealing views show you exactly how specific locks work, and exactly what you have to do to service and maintain them. From simple warded locks to intricate combination locks, all the illustrations and data you need are here.

The detailed Chapters on keying show you how to make any key for any lock. Precise, step-by-step instructions tell you how to cut keys by hand, how to make key impressions, how to "read" locks, and how to decipher key codes. The author carefully explains all the professional keying techniques, and all the tricks of the trade that go along with them.

There's even a thorough treatment of one of the most important locksmithing skills of all—opening locks. Clear instructions show you how to open all kinds of locks—the easy ones and the hard ones. You learn which picks to use, where to apply pressure, what to look for, how to "feel" the tumblers. There's even a whole Chapter on emergency entry procedures that locksmiths use when picking fails.

You get practical information on home services like installing locks, replacing locking mechanisms, changing lock hands, extracting broken keys, and altering lock combinations. You learn how to troubleshoot everyday home, shop, and office lock problems. There's plenty of supplementary information, too—like a glossary that defines all the professional locksmithing terms, an Appendix that tells you how to select a good lock, and a Chapter on locksmithing and the law. There's an entire section that shows you how to set up your own lucrative locksmithing business—an exciting trade marked by its high standards of ethics and service to the community.

Whether you're an amateur locksmith who wants to go professional, or a budget-minded homeowner who wants to repair your own locks or make your home, car, office or store more secure. "The Complete Handbook of Locks and Locksmithing" has everything you need to do the job right: easy-to-read instructions; complete, professional information; and clear, definitive illustrations. 392 pps., 200 illus. Hardbound. Publisher's List Price $10.95.

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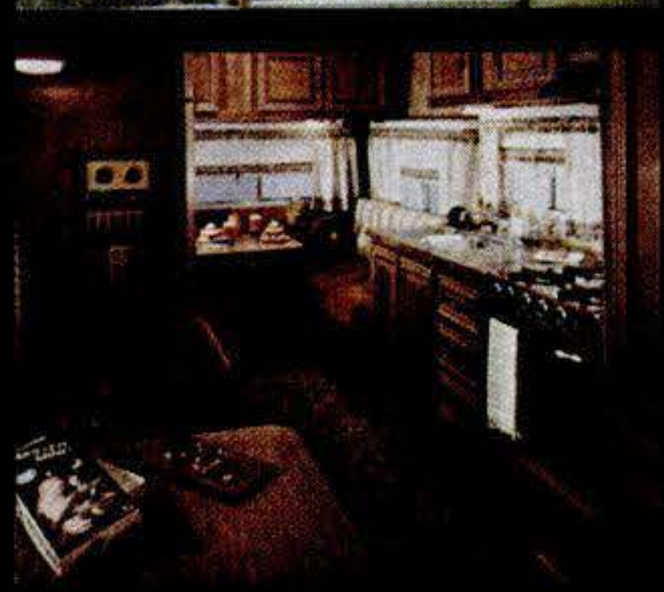

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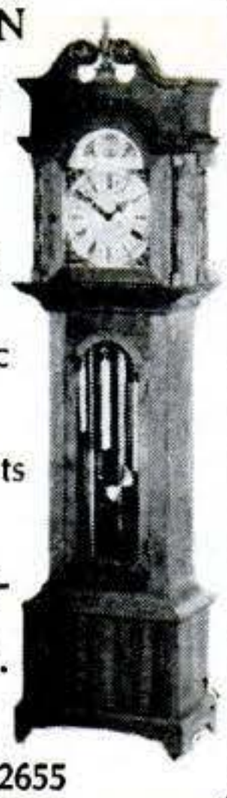

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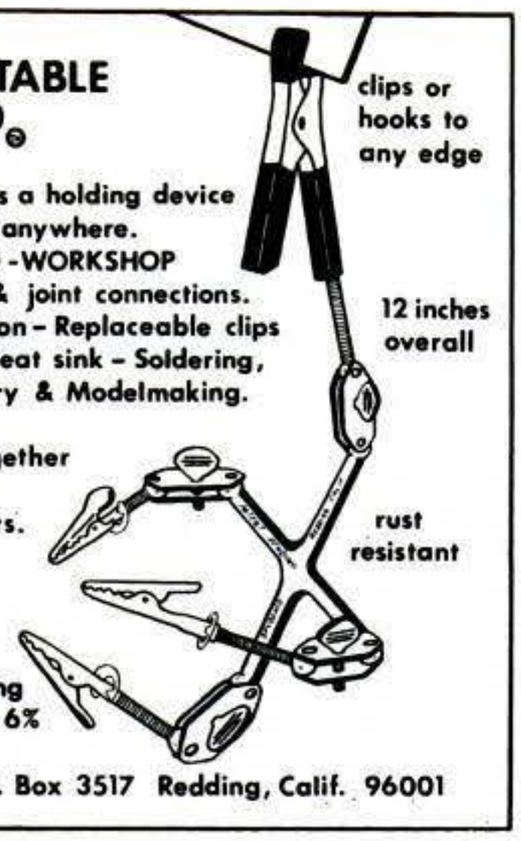

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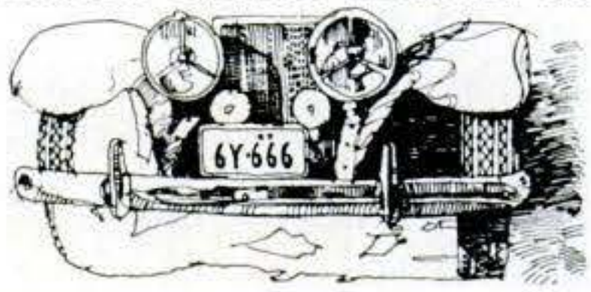
Every day we receive letters from Bon Ami users telling of new uses for Bon Ami Cake and Powder. We want to pass these along to you and tell you why Bon Ami is such an unusual and unique cleaning product.

FROM OUR LABORATORY:
Since 1886 Bon Ami's base mineral has been pure white feldspar. One unusual characteristic of feldspar is that, microscopically, it has far fewer jagged edges, a more rounded, smoother crystal. Other cleaners use silica as a base and this mineral retains jagged edges when crushed and has a greater tendency to scratch and mar many surfaces.

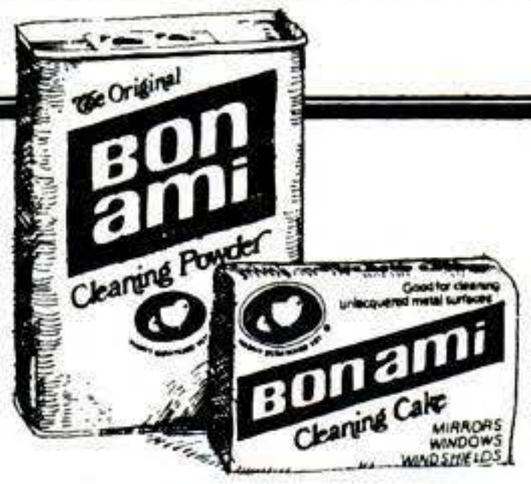
During the late 1800's and early 1900's feldspar was mixed by workers using large metal shovels. After awhile, these shovels looked nearly like silver from the constant mixing of the polishing feldspar mineral.

Unlike most products today Bon Ami Cake and Powder are still made with the same basic ingredients used in 1886. Bon Ami is a natural product that can clean many delicate hard surfaces like glass, stainless steel, porcelain, ceramic tile and chrome without scratching them.

FROM OUR CUSTOMERS:
1. A year ago we purchased a glass topped stove and since that time I have used Bon Ami bars to clean it. I have found this the fastest, safest and best way to clean the numerous spills and boil-overs that occur in my household. K. D., Oregon
2. My husband is a photographer and uses Bon Ami Cake for cleaning chrome drums and equipment. A. Q., Michigan
3. I live in a mobile home and find it quite difficult to keep the outside windows clean because dirty water runs off the roof. I know your product would do the trick. O. R. L., Washington
4. It cleans road film from auto windows and rain spots from house windows. C. M. S., Arizona
5. I find Bon Ami good for cleaning TV picture tubes and chromium. E. O., New Jersey
6. I am an antique and classic car buff and own a 1955 Chevrolet and a 1937 Chevrolet Roadster, both vehicles have lots of chrome and polished aluminum and NOTHING will clean them like Bon Ami. D. W. L., Texas



7. It is the one and only scouring powder that a person with any kind of respiratory condition should use. K. B., New York
8. I found it to be very satisfactory for cleaning my white woodwork. J. L., Ohio



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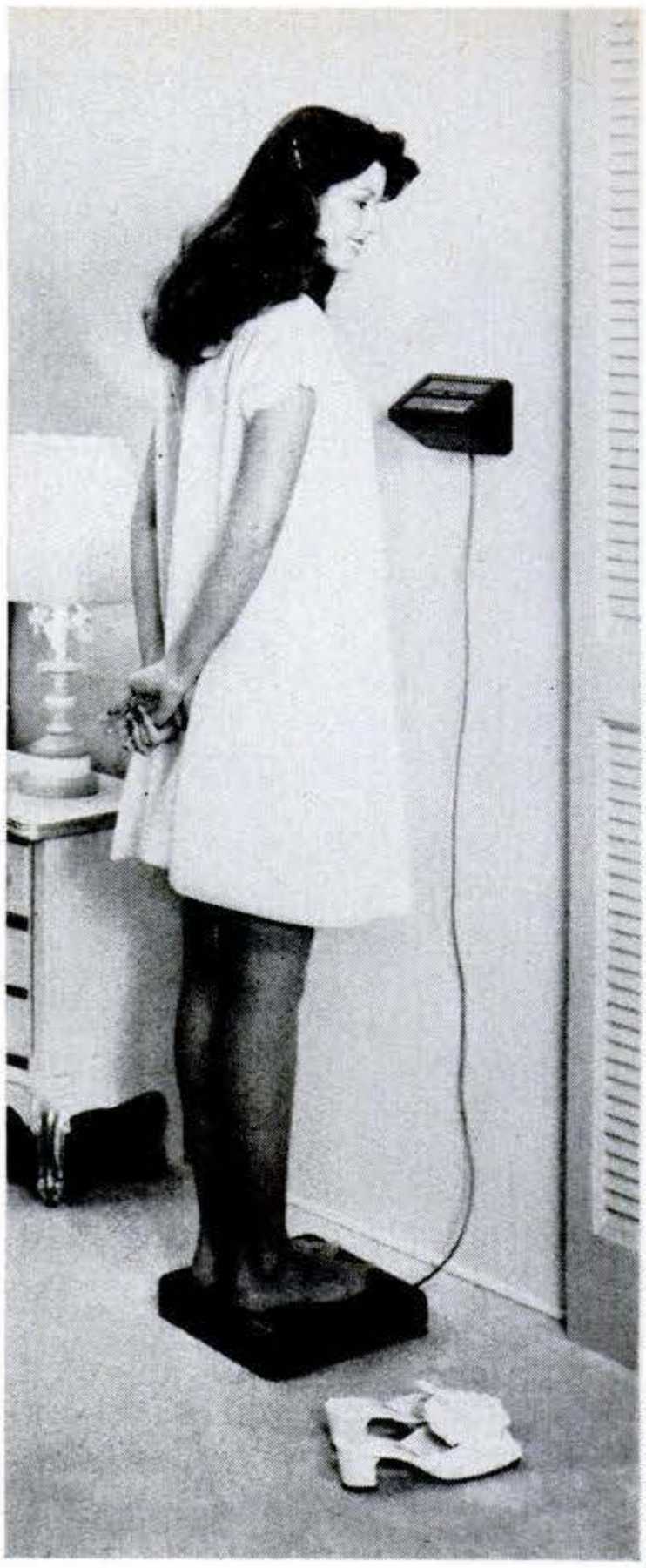
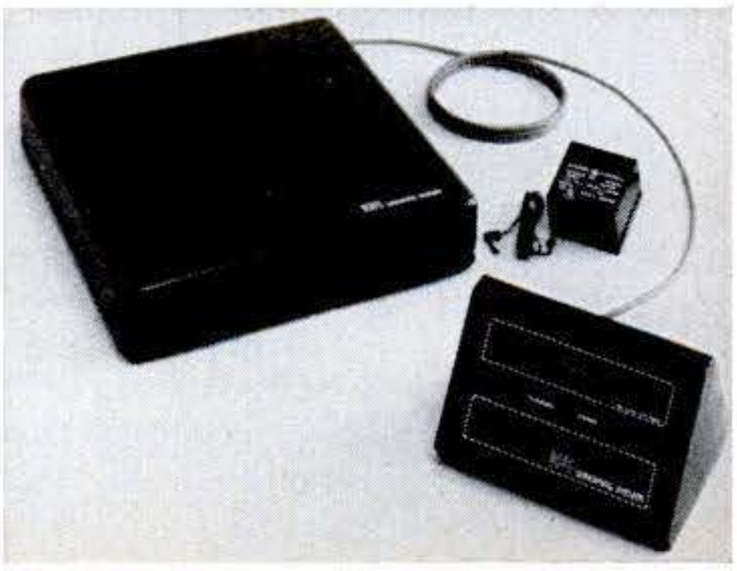


Electronic scale

You can see your weight without having to stoop over when you step on the sensing pad of this new electronic weighing system. It's wired to an LED digital readout that you can attach to a wall or rest on a piece of furniture.

The scale reads out in both kilos and pounds, and has a capacity of 275 pounds (125 kilos). Accuracy is plus or minus one pound. Four C cells or an AC adapter power the unit. It's made by Borg-Erickson, 1133 North Kilbourn Ave., Chicago, Ill. 60651, and costs $150.



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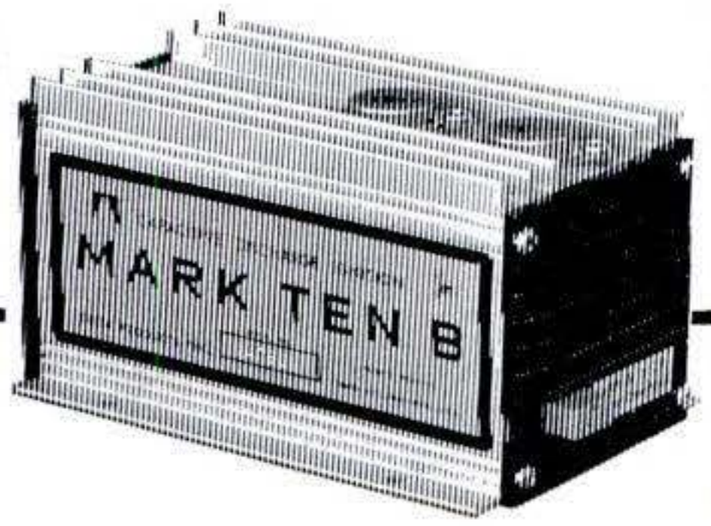

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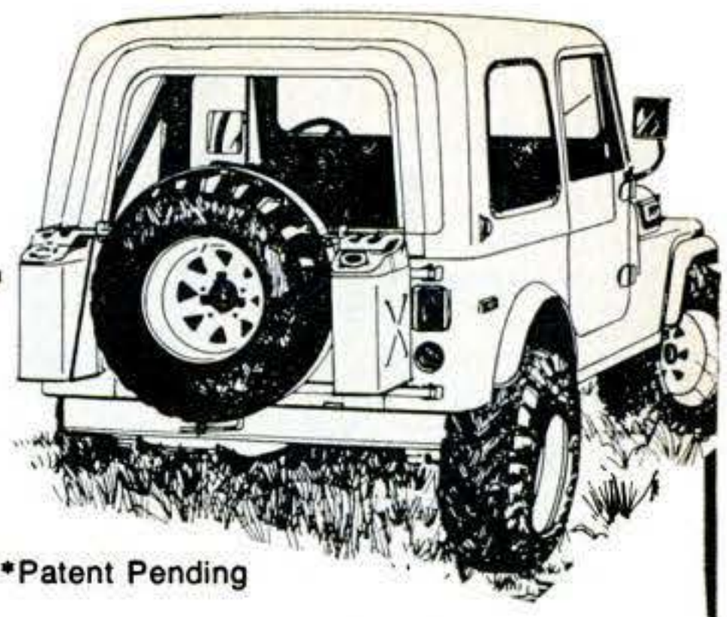

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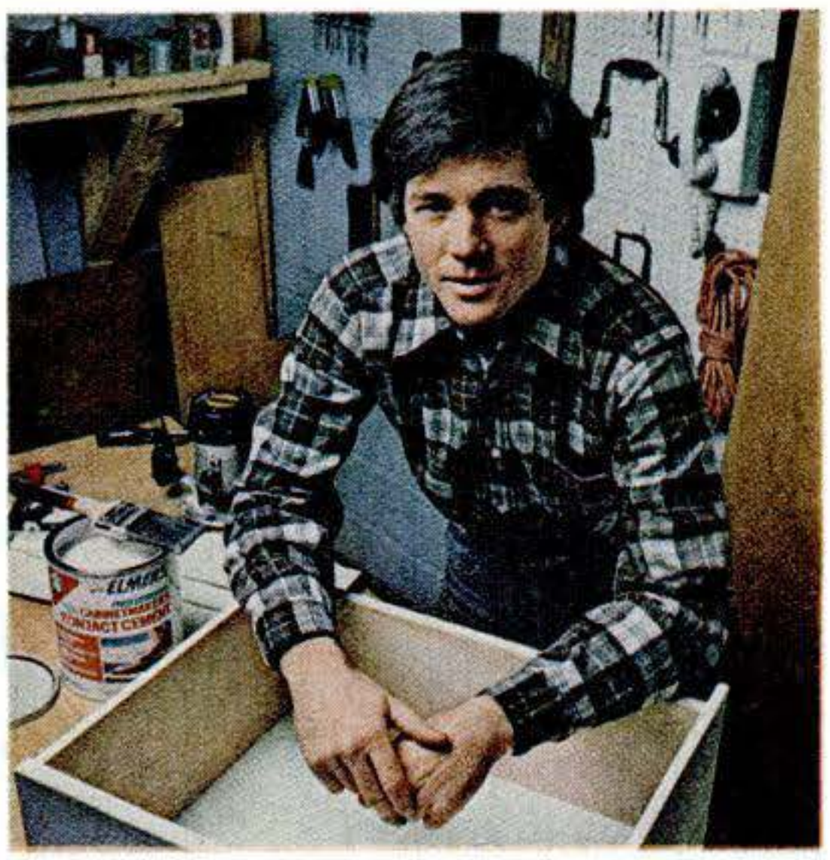
Dick Carey, Professional Cabinetmaker



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They put two laminates in a 220°F. test oven for four days. The laminate they'd glued down with Cabinetmaker's stayed down. It's a real acrylic.

Of course, since new Cabinetmaker's goes on with a brush or a roller, and dries crystal clear to let me know when it's ready to bond, it's also easier to use.

And it cleans up with plain warm water, which is pretty easy.

Oh. Another thing. New Cabinetmaker's goes up to twice as far as conventional solvent-based contact cement and has no harmful fumes so you don't have to worry about fires.

It's no wonder things are so much easier for me now."

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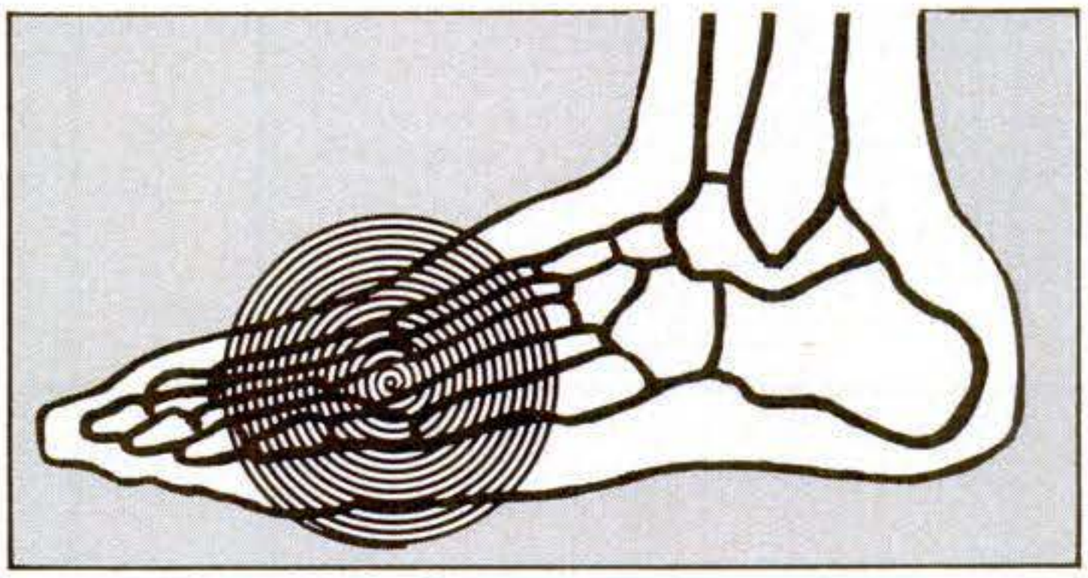
My Feet Were Killing Me...Until I Discovered the Miracle of Hamburg!



It was the European trip I had always dreamed about. I had the time and money to go where I wanted—see what I wanted. But I soon learned that money and time don't mean much when your feet hurt too much to walk. After a few days of sightseeing my feet were killing me.

Oh, I tried to keep going. In Paris I limped through Notre Dame and along the Champs-Elysées. And I went up in the Eiffel Tower although I can't honestly say I remember the view. My feet were so tired and sore my whole body ached. While everybody else was having a great time, I was in my hotel room. I didn't even feel like sitting in a sidewalk cafe.

The whole trip was like that until I got to Hamburg, Germany. There, by accident, I happened to hear about an *exciting breakthrough for anyone who suffers from sore, aching feet and legs.*

This wonderful invention was a custom-made foot support called Flexible Featherspring. When I got a pair and slipped them into my shoes *my pain disappeared almost instantly.* The flexible shock absorbing support they gave my feet was like cradling them on a cushion of air. I could walk, stand, even run. The relief was truly a miracle.

And just one pair was all I needed. I learned that women also can wear them —even with sandals and open backed shoes. They're completely invisible.

Imagine how dumbfounded I was to discover that these miraculous devices were sold only in Europe. Right then I determined that I would share the miracle I discovered in Hamburg with my own countrymen.

Today thousands of Americans of all ages—many with foot problems *far more severe* than mine—have experienced this blessed relief for themselves.

Here's why Featherspring work for them and *why they can work for you.* These supports are like nothing you've ever seen before. They are custom fitted and made for *your feet alone!* Unlike conventional devices, they actually imitate the youthful elastic support that Nature originally intended your feet to have.

Whatever your problem—corns, calluses, pain in the balls of your feet, burning nerve ends, painful ankles, old injuries, backaches or just generally sore, aching feet. Flexible Featherspring will bring you guaranteed relief with every step you take.

Don't suffer pain and discomfort needlessly. If your feet hurt, the miracle of Hamburg can help you. Write for more detailed information. There is no obligation whatsoever. Just fill out the coupon below and mail it today.

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YES! I want to learn more about the guaranteed relief Flexible Featherspring Foot Supports can give. Please send me your free brochure. I understand that there is no obligation and that no salesman will call.

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Tough electric saw
for when the going's hard

I'm glad I didn't take on Stihl's bet that I couldn't stall the new E10 electric chainsaw in a log; I would have lost. To be truthful, I tried—way out at the end of a 100′ extension cord, because that's the way many electrics are used. I laid on it hard, with the bucking teeth digging deep into a pitch-oozing log calculated to give this little saw a fit. The E10 kept on biting.

The Stihl E10 is not your garden variety of small electric saw. At $134.95 with a 10″ bar, and $149 with a 12″ bar, it shouldn't be. On the other hand, it's beautifully built and has automatic-pump, not thumb-push, chain oiling. The piston pump drives directly off the helical reduction gearing on the heavy-duty armature. The same gearing accounts for the saw's high torque, and drives the chain sprocket at 4000 rpm. The rating for the 115-volt, 60-Hz model is 10 amps, and you should be fused for 20. There's also a 220-volt 50-Hz model.

The E10 with bar and chain weighs 9.04 lb.—not superlight but with an extremely smooth, solid feel and freedom from the chattering and vibration that most small electrics seem to have. This means that if you want to use it for heavy carpentry you can make rather accurate cuts with fewer ripples and waves in the cut surface. The E10 is a dandy for pruning, too—take it wherever there's a power line.

The E10 is made by Stihl, Inc., 5701 Thurston Ave., Virginia Beach, Va. 23455.—*E. F. Lindsley*

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Hobby welder
heats and brazes

This new hobby welder plugs into any 20-amp, 115-volt outlet, and is small enough (31 pounds) to store anywhere. Yet the new Sears welder easily welds 1/8″ steel, and brazes and heats with a carbon arc.

Don't expect luxury details for $54.50. There's no way to vary output from the basic 50 amps—the cables are permanently wired into the cabinet; and the electrode holder and ground clamp are lightly constructed, and double as a carbon-arc torch. What you do get is a high-quality welding transformer in a metal box with an on-off switch.

If you want to know the truth, the little sputter box will do quite a bit more than hobby work. With 3/32″ rod it welds beautifully on 1/16″ sheet metal, a job that's not so easy with heavier machines. Clamp in a 1/16″ rod and you can run a neat weld bead about 3/16″ wide on 1/8″ stock. With multiple beads you can weld some fairly heavy items—a trailer hitch on a tongue, for example. I found the arc-starting easy and the arc stable.

For a brazing torch you slip the electrode holder over the ground-clamp handle to form a spring-loaded wishbone that squeezes together to touch the carbons and strike the arc. Call it a hobby welder, but the 9 GT 20175C (Sears catalog no.), capable of 9000°F, does the job—hobby or not.—*E. F. Lindsley*

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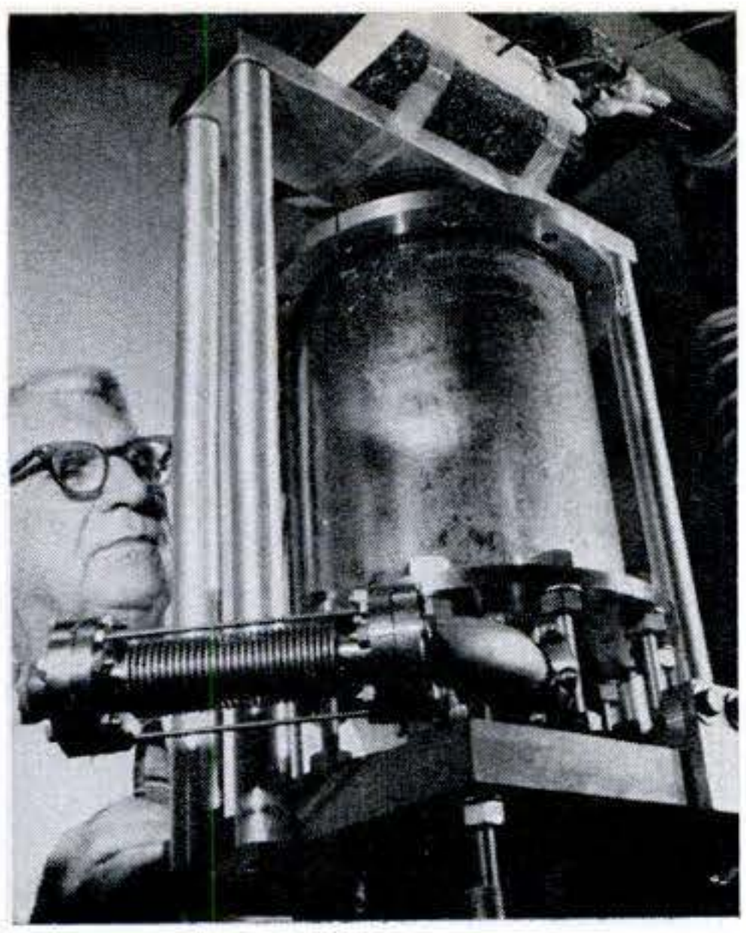

High-voltage interrupters give improved protection

A vacuum interrupter that will allow high-voltage power to be transmitted to places it could never reach before is being developed by General Electric.

An interrupter is like a giant circuit breaker. It has contacts that open automatically to interrupt high short-circuit current caused by lightning or other transient phenomena. When the contacts open, the gap is bridged by a flaming arc that reaches temperatures of up to 20,000 degrees F. Depending upon the type of interrupter, the arc is extinguished by oil, a blast of air or gas, or a vacuum. Thus transmission lines and power stations are protected from damaging overloads.

Vacuum interrupters are more compact than other types and require much less maintenance. And unlike the others, they emit no smoke or flames when extinguishing arcs. Most important, they are much quieter than any other type of interrupter—and this is primarily why they are being developed.

Vacuum interrupters now service lines of 38,000 volts or less. With the demand for electricity still increasing, utility companies would like to bring higher-voltage power lines—of up to 69,000 volts—directly into heavily settled areas.

Residents could not live with the gunshot noise of conventional interrupters. But the newer vacuum interrupters, fully enclosed and almost noiseless, should go virtually unnoticed.—*Rich Ceppos*

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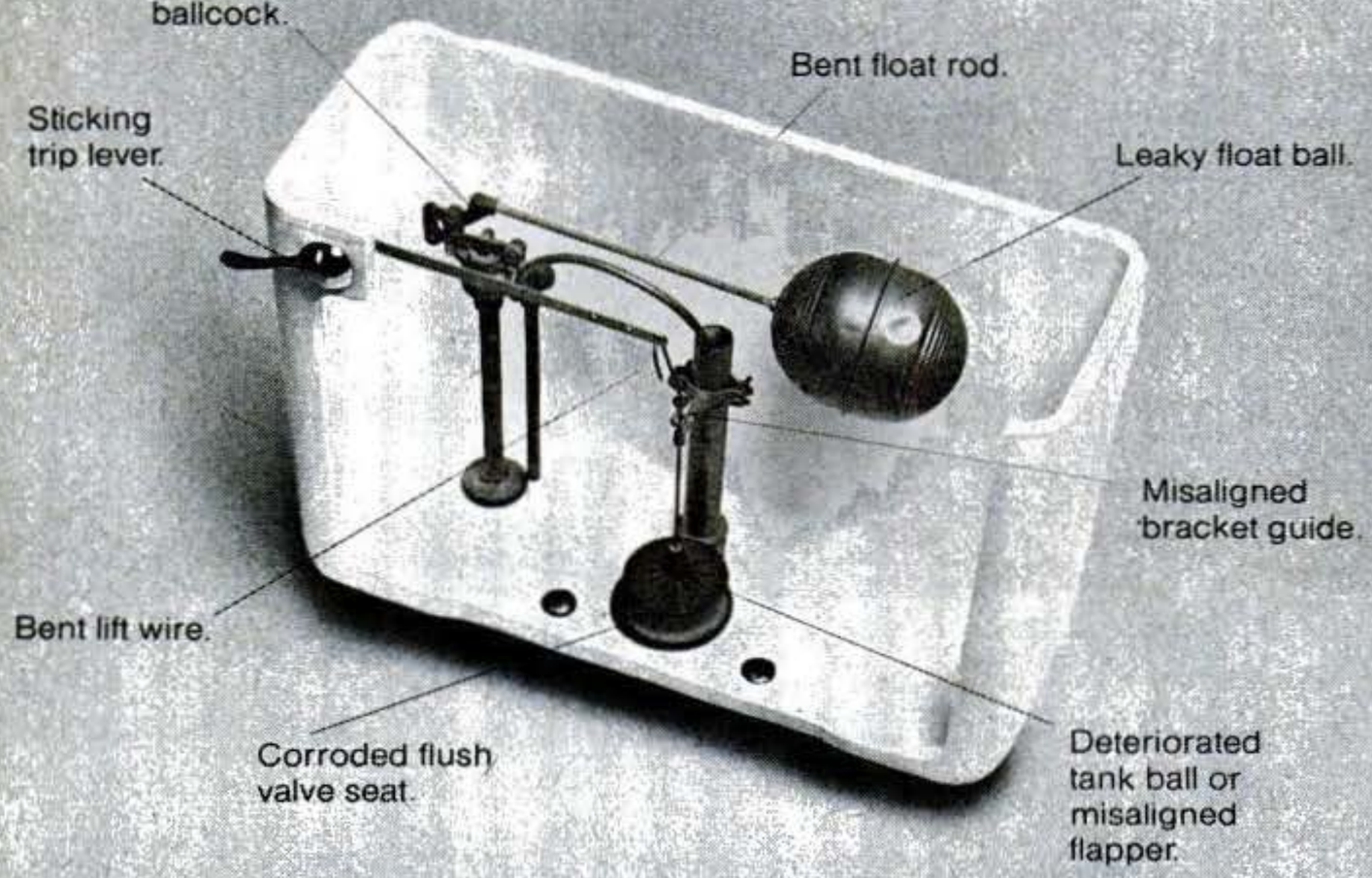
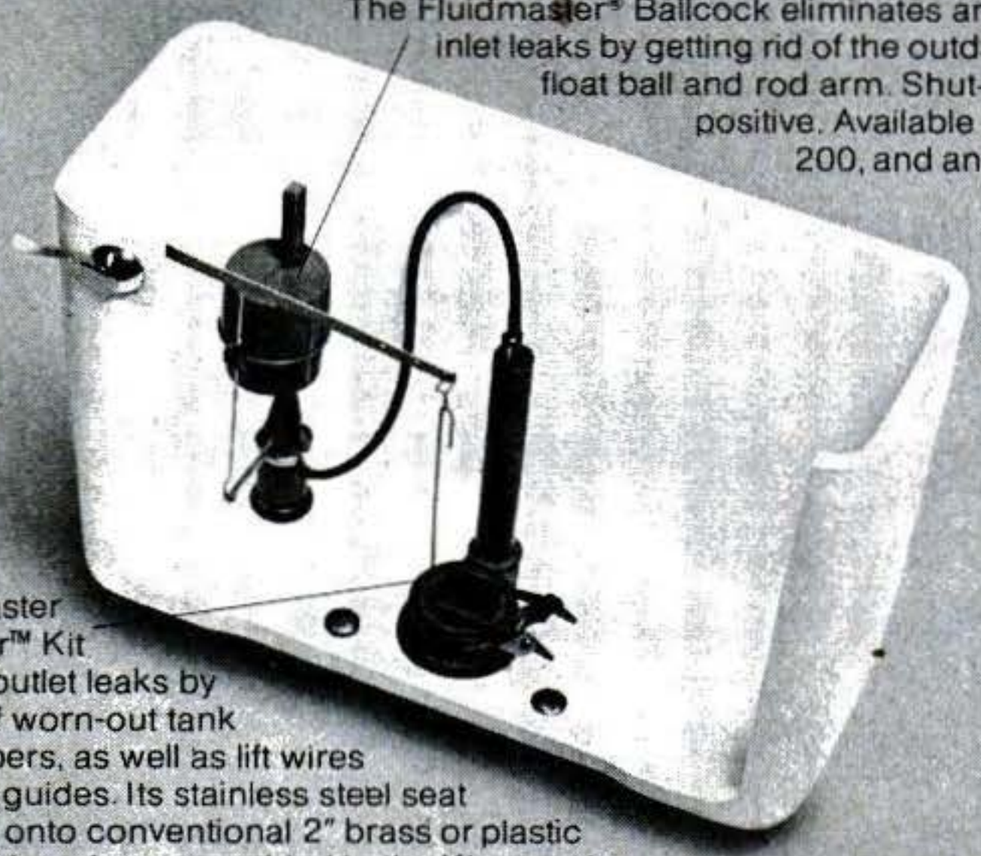


What makes Johnny stop.

The Fluidmaster® Ballcock eliminates annoying water inlet leaks by getting rid of the outdated ballcock, float ball and rod arm. Shut-off is fast and positive. Available in Model 100, 200, and anti-siphon 400.



The Fluidmaster Flusher Fixer™ Kit solves tank outlet leaks by getting rid of worn-out tank balls or flappers, as well as lift wires and bracket guides. Its stainless steel seat bonds easily onto conventional 2" brass or plastic flush valves. An adapter, provided in the Kit, permits easy installation on most china or other special seats.

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How to use those handy **string trimmers**

Sure, string trimmers are inherently safe (see page 50), but you should still wear shoes, long pants, and protective goggles when using one. A trimmer won't throw rocks, but it will stir up dust and zing small stones and grit. And, if you cut with the right edge of the tool, it will sling stuff back at you. Prevent this by tilting the tool so its left side does the cutting.

Don't try to solve the problem of fast line wear by substituting a piece of metal wire for the nylon line. Tiny, sharp bits of wire that can penetrate your ankles will come sailing off as you work.

For easy trimming, work with a light touch, and let the tip of the line do the cutting. Don't force the tool. If you try to rush, you'll only wear the line faster and overload the tool.

Carry a pair of pliers with a cutter. When the line wears down so short that it's hard to get a good grip, use the pliers to pull out a new length. Cutters are handy when the tip of the line frays and loses cutting efficiency. Just snip off the frayed tip and the tool will begin cutting better.

To get a neat yard with the least effort, trim a large circle around trees, posts, and bushes, then cut very, very close to the ground. This way, you'll only have to trim three or four times a season, instead of once a week. You save a lot of work—but there is one disadvantage. You cheat yourself out of opportunities to use your magic wand.—*A. J. Hand*

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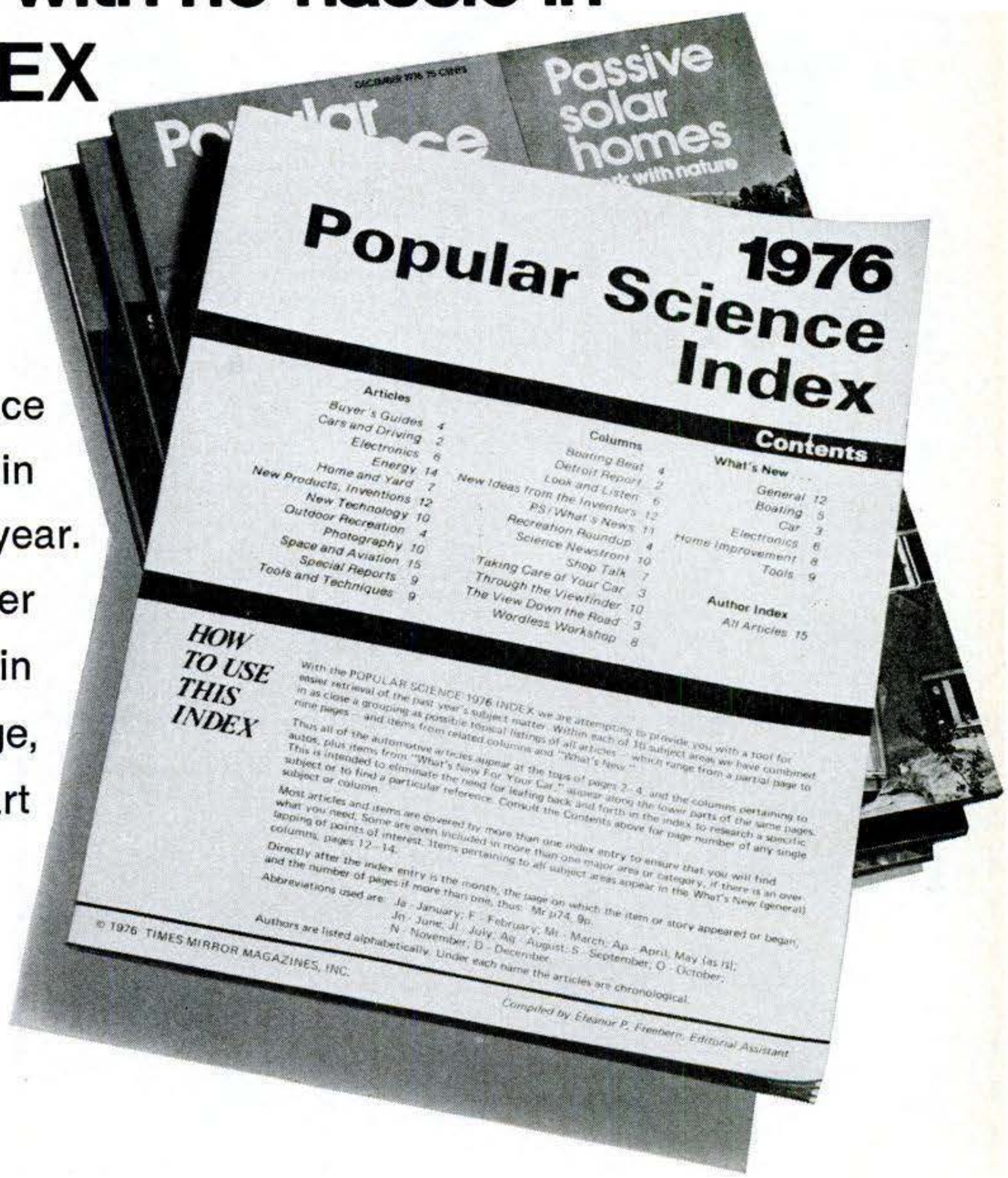

Over 5000 listings reference every item that appeared in the magazine during the year. Listings are grouped under the same headings used in the monthly contents page, so you know where to start looking. The 1976 index has been set in clear, easy to read type.

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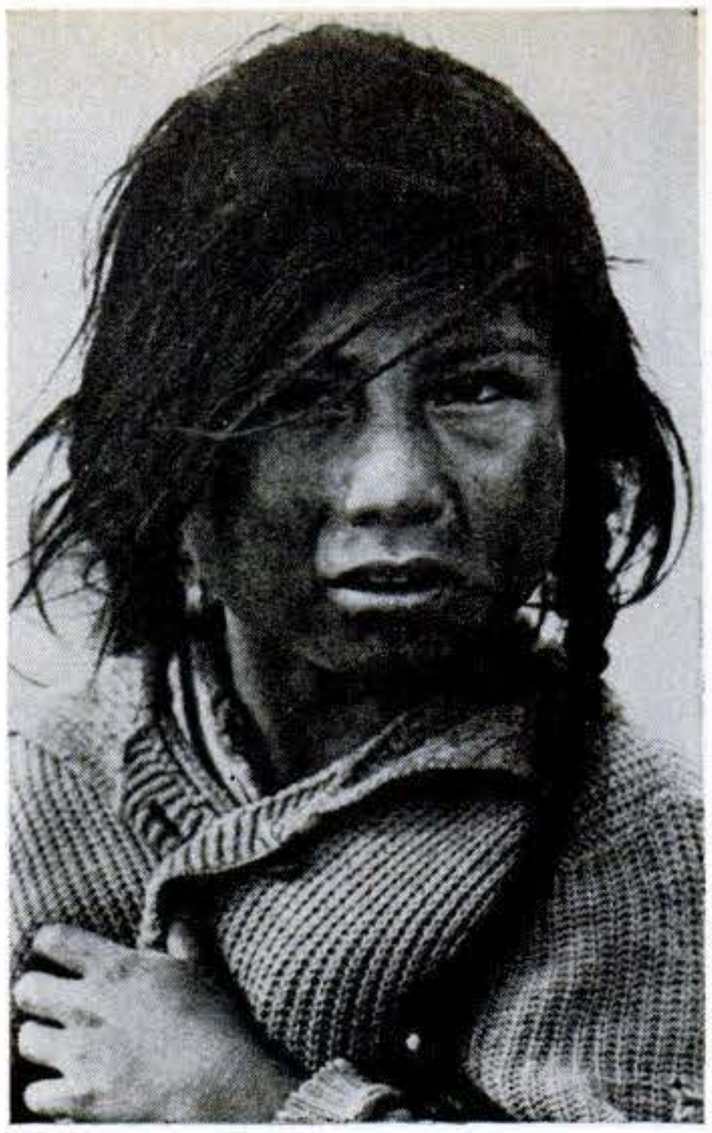

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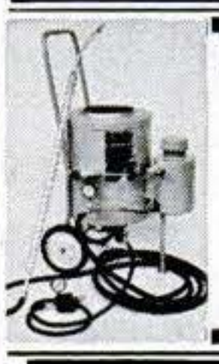

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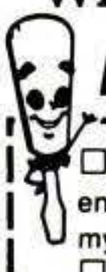

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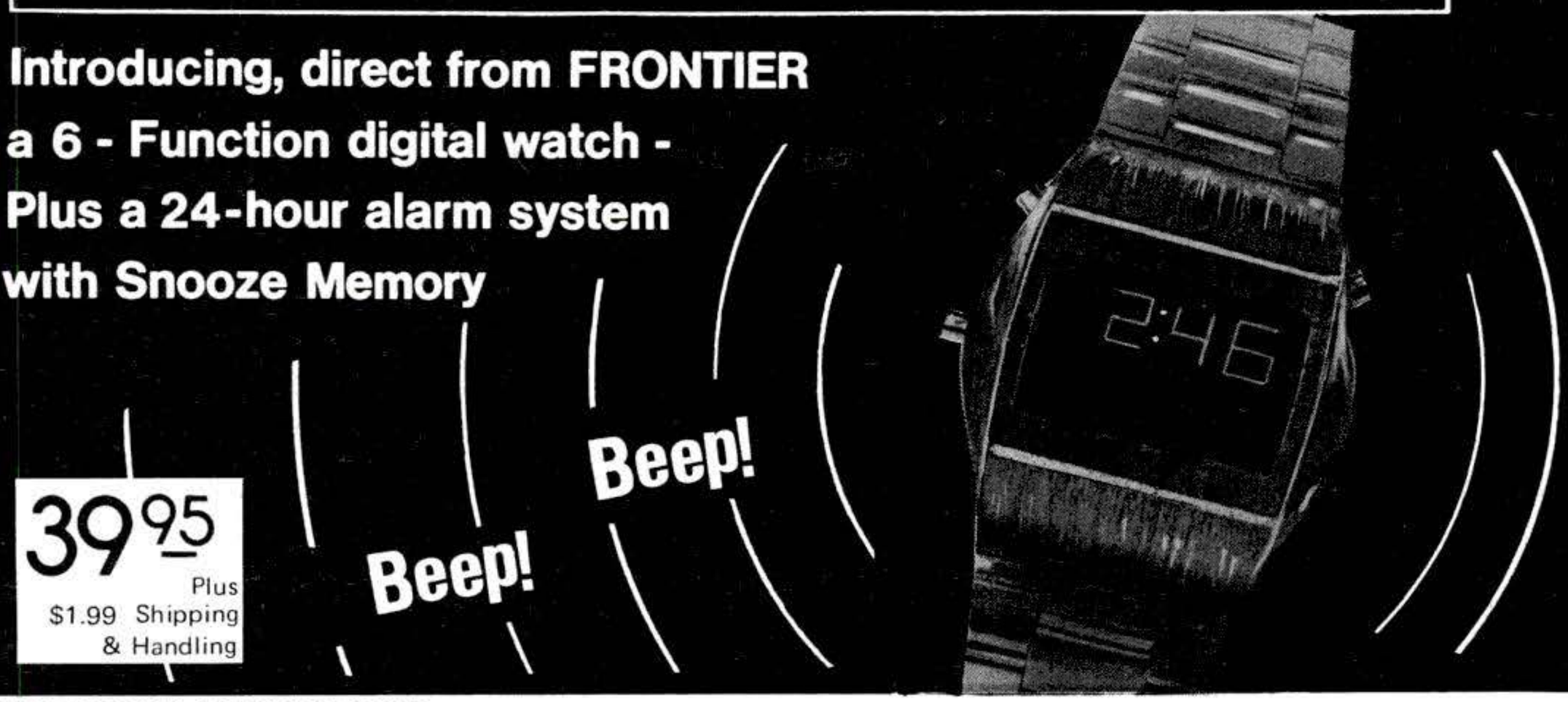

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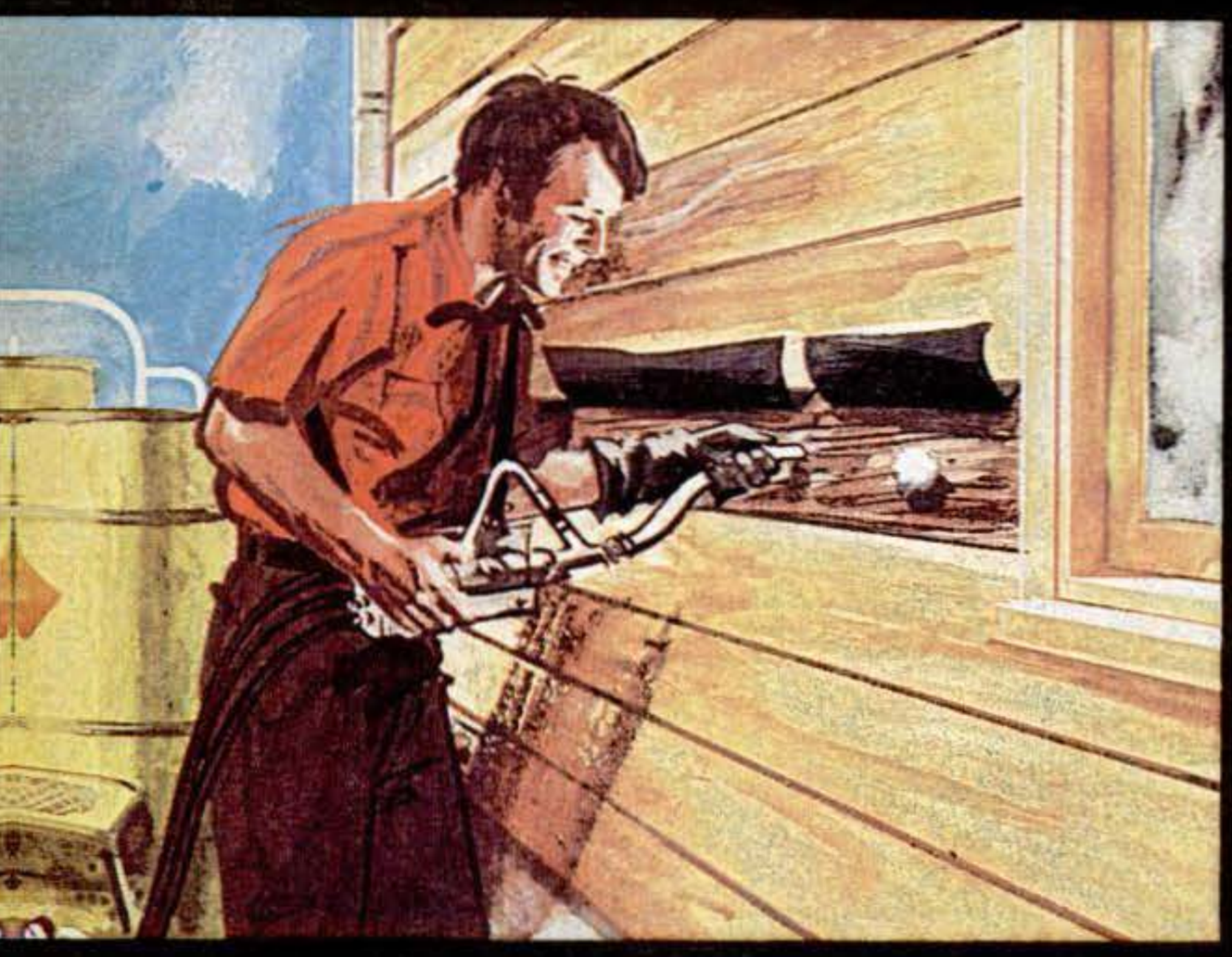

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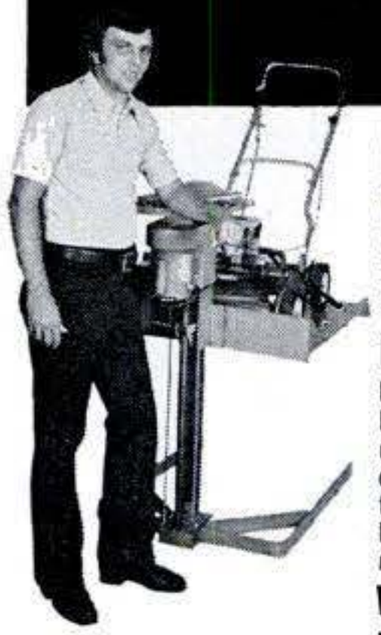

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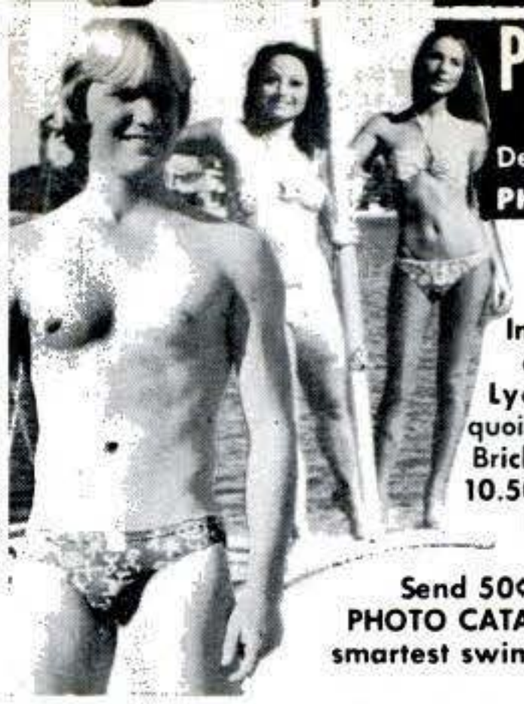

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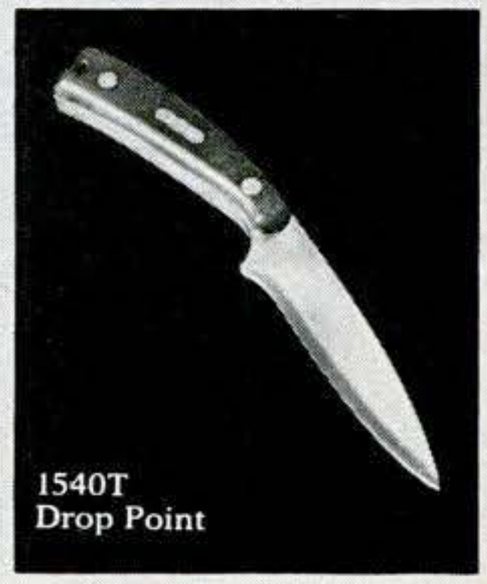

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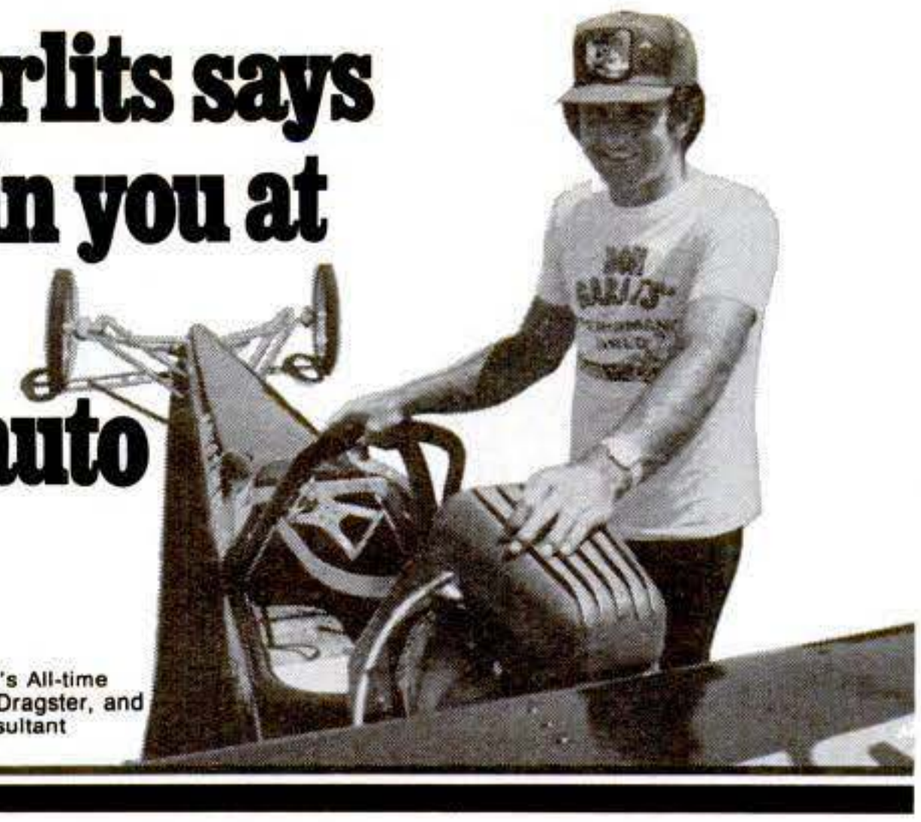

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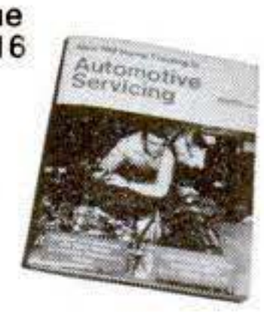

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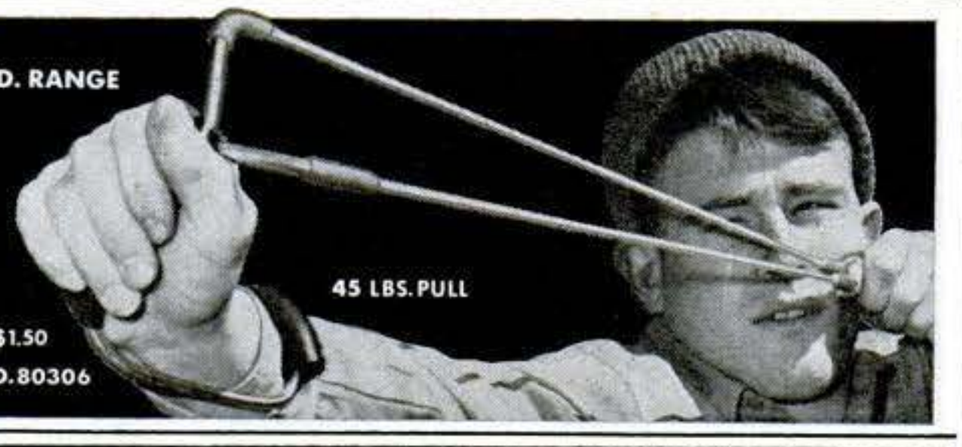

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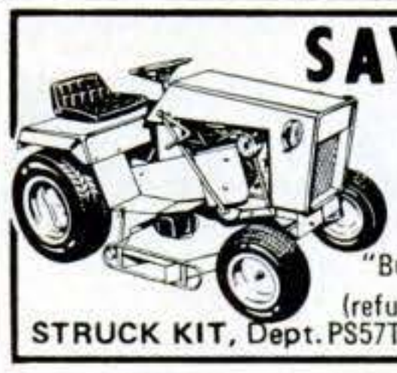

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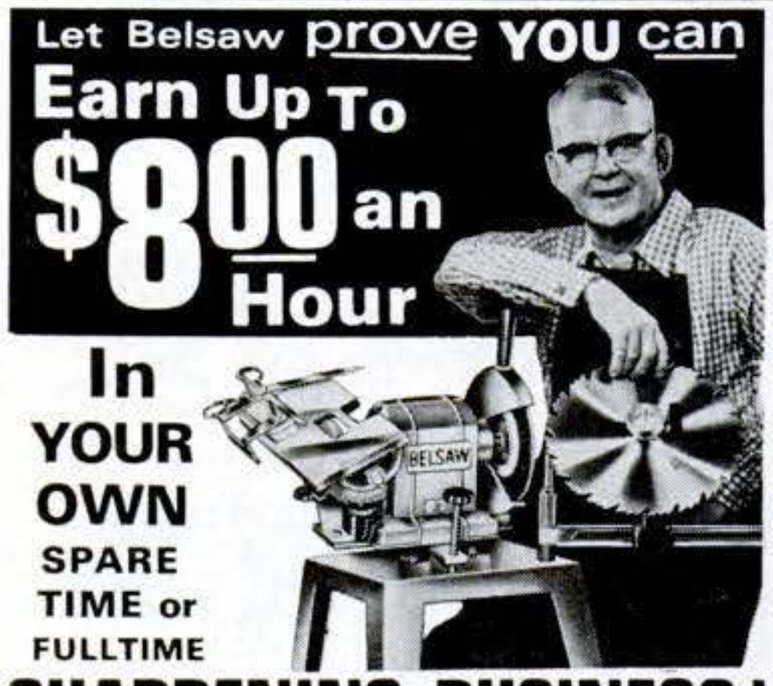

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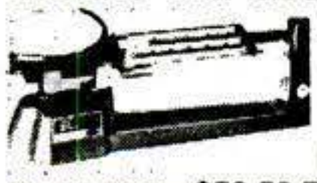

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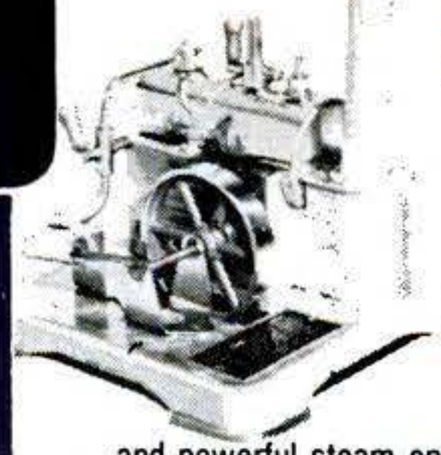

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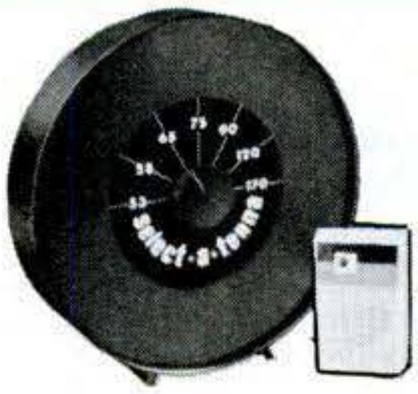

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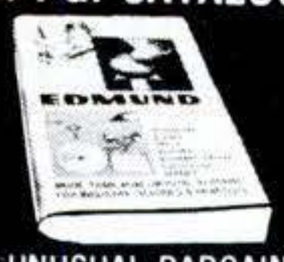

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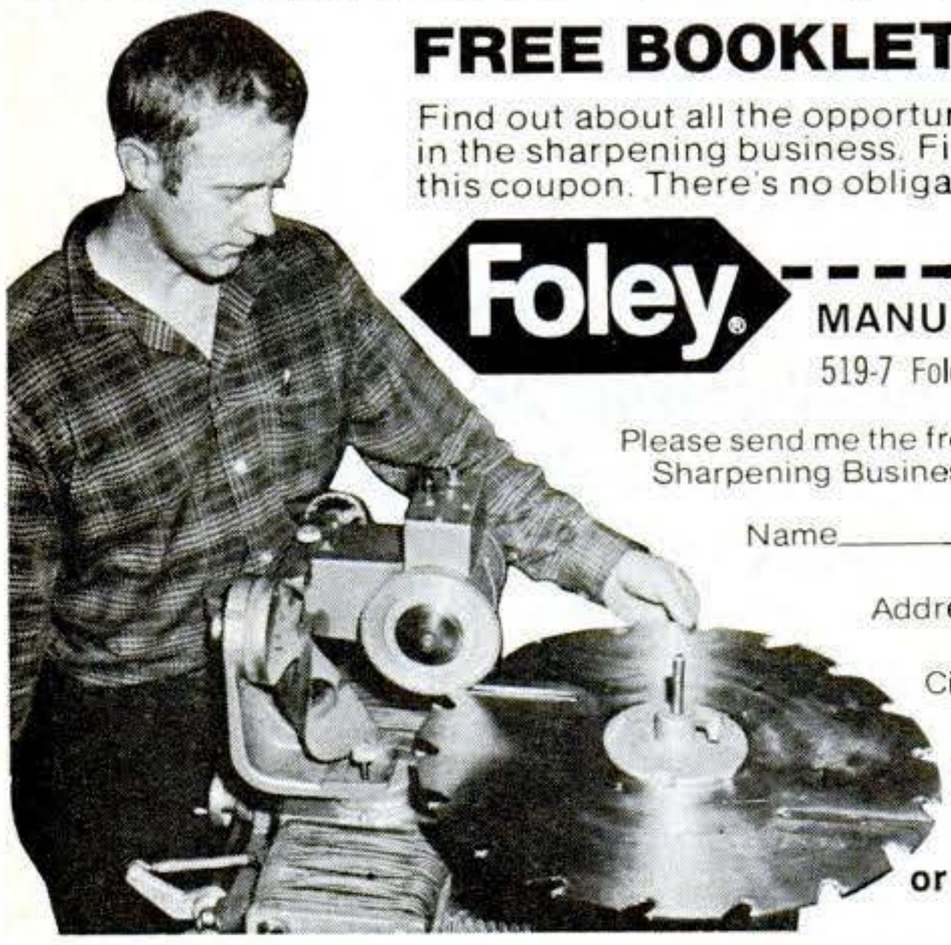

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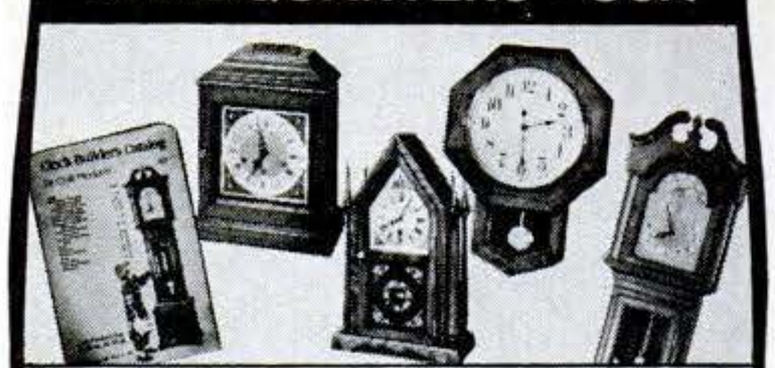

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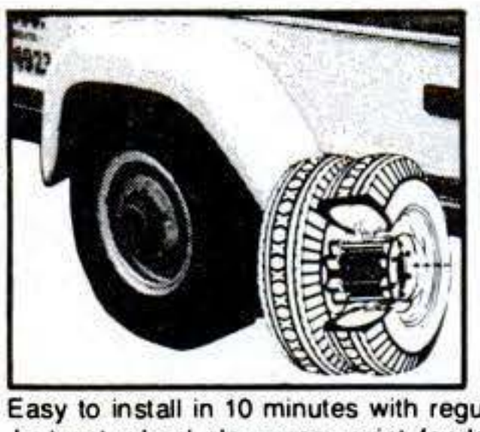

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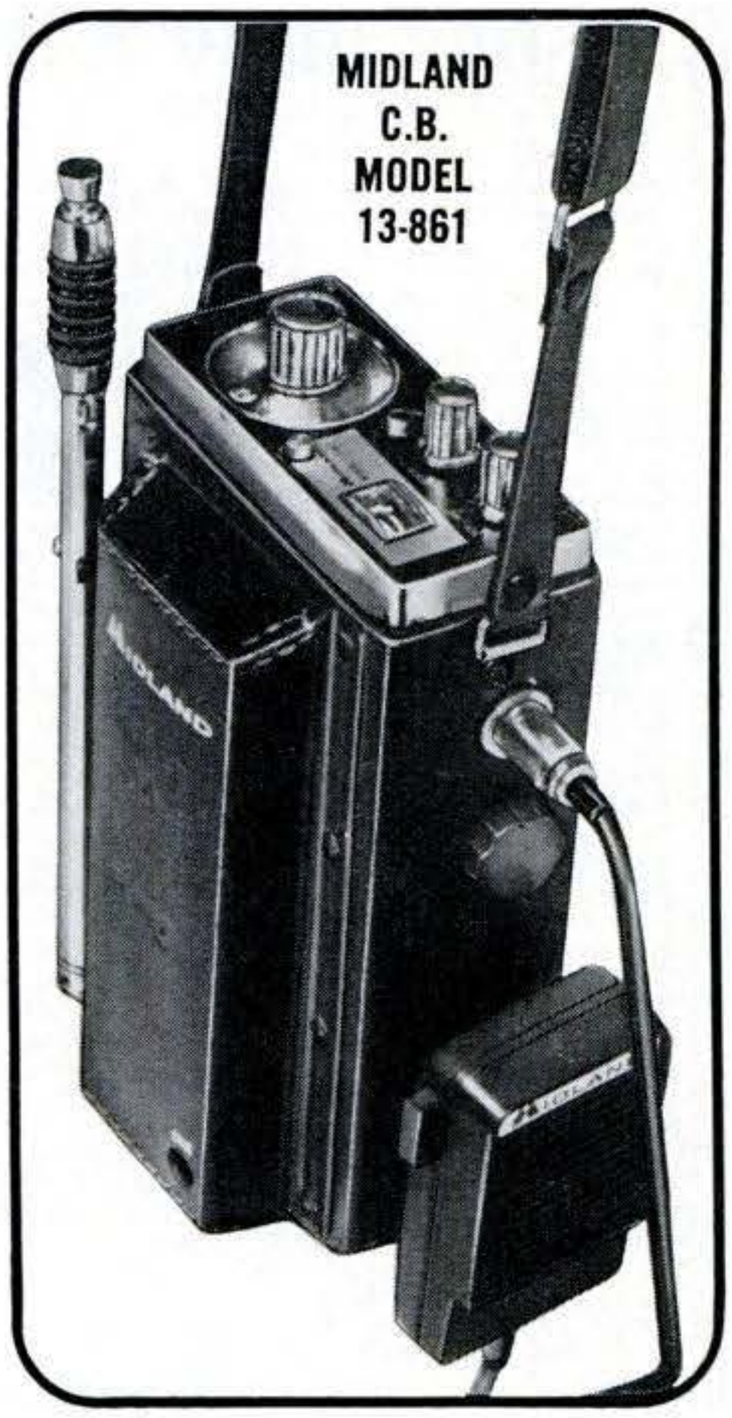

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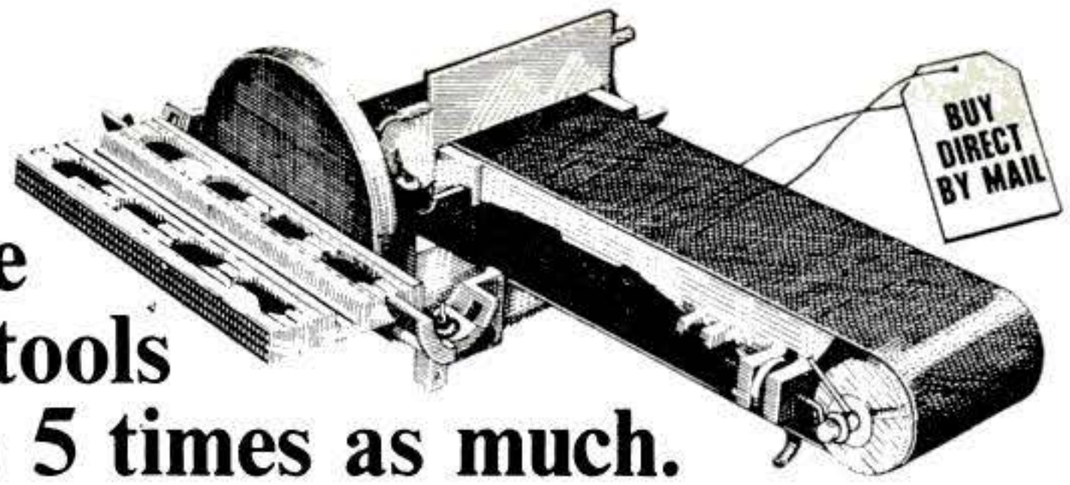

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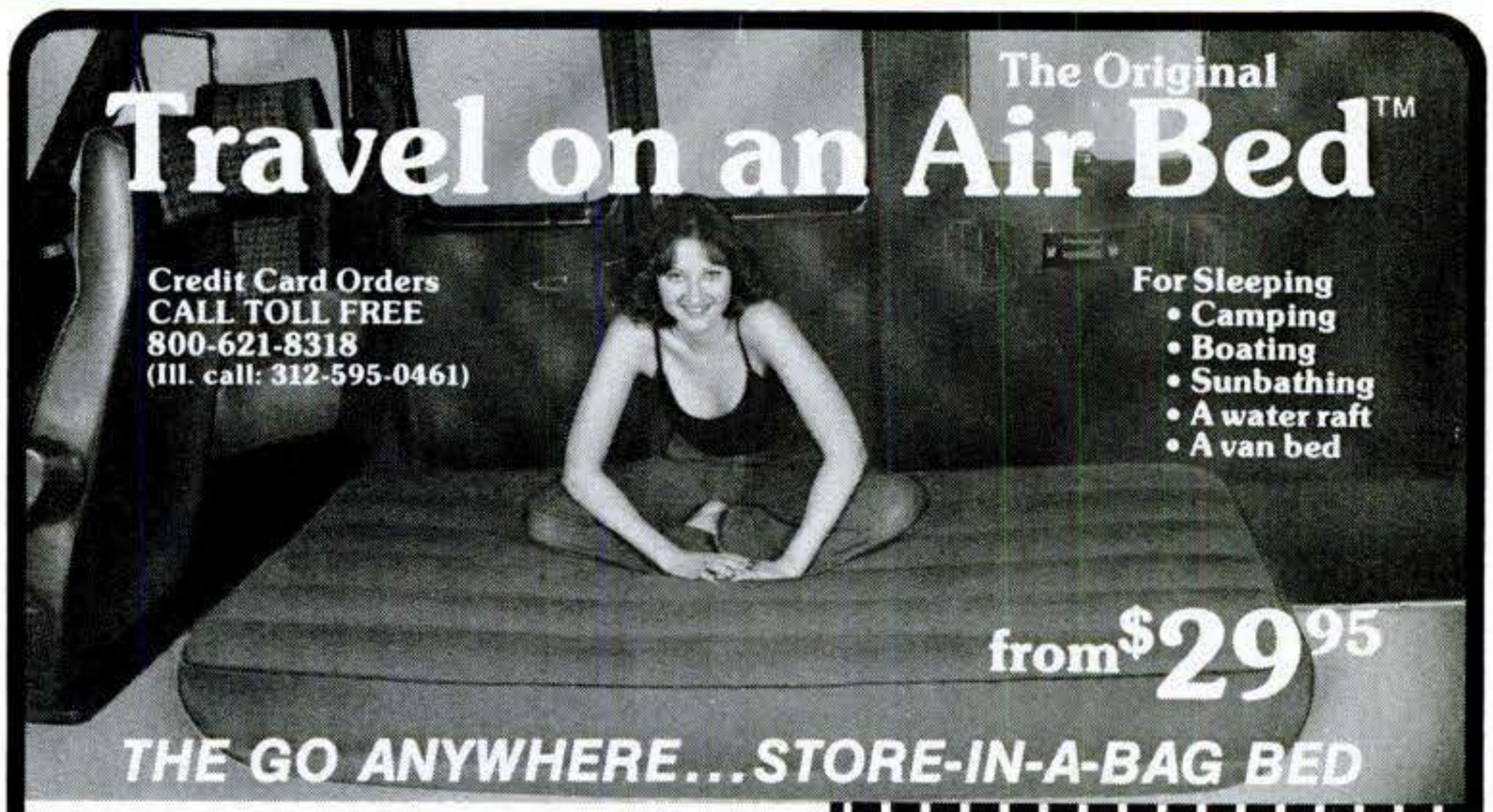

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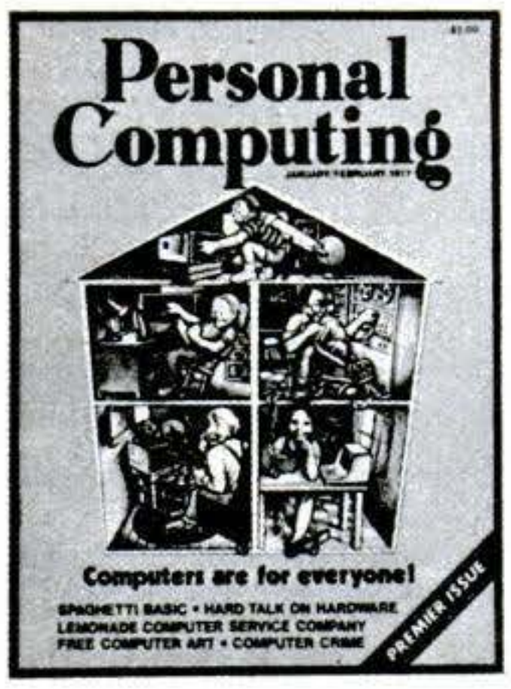

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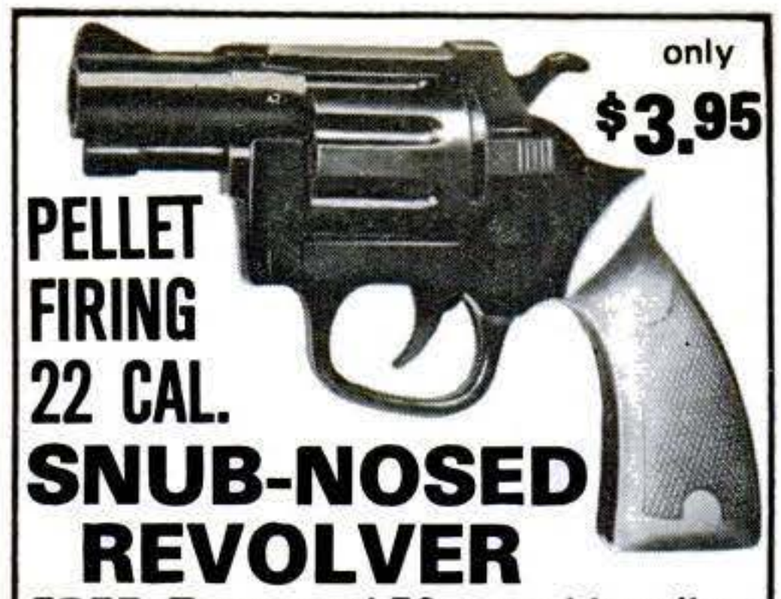

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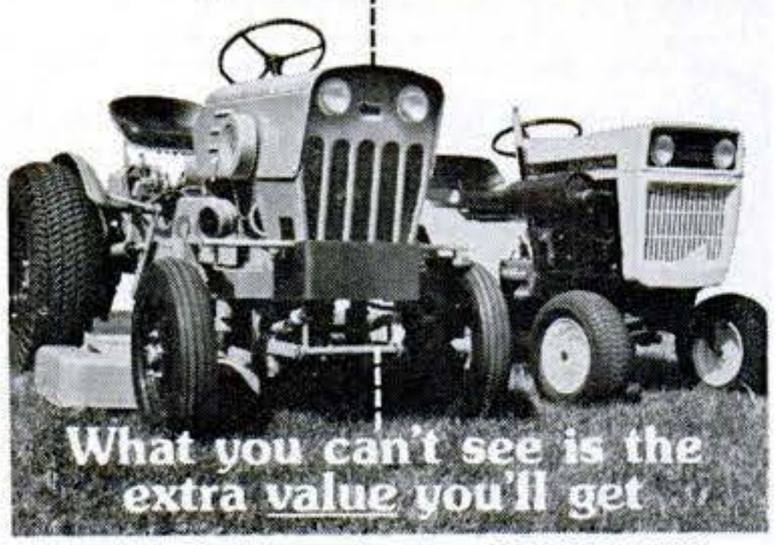

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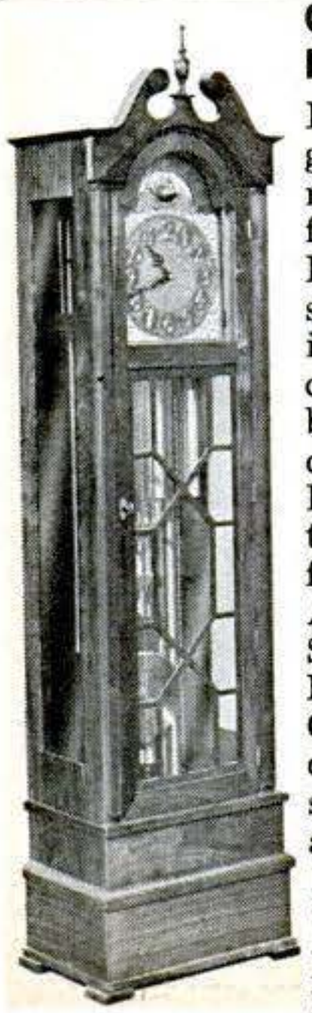

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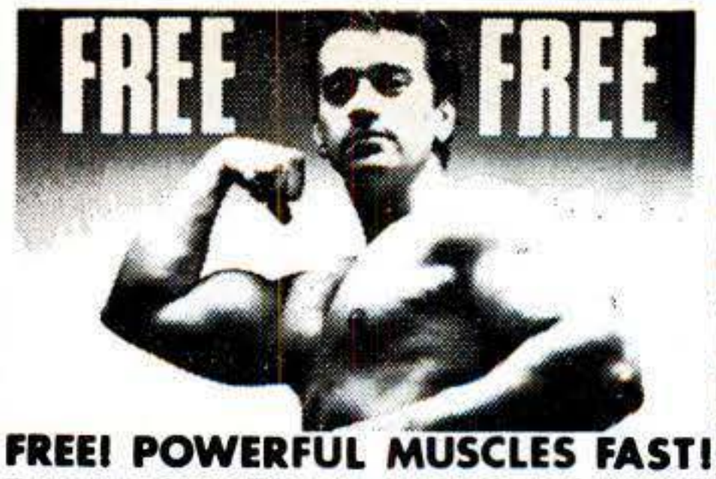

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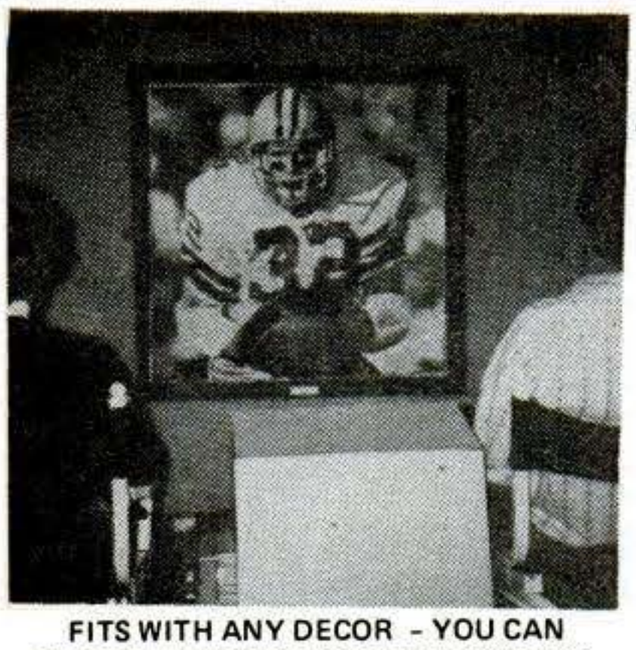

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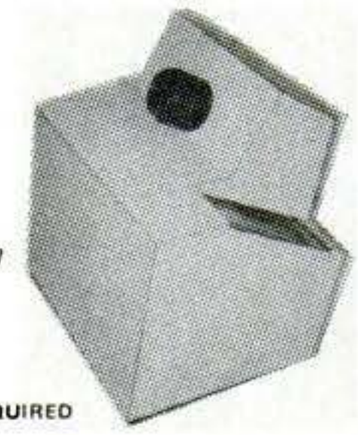

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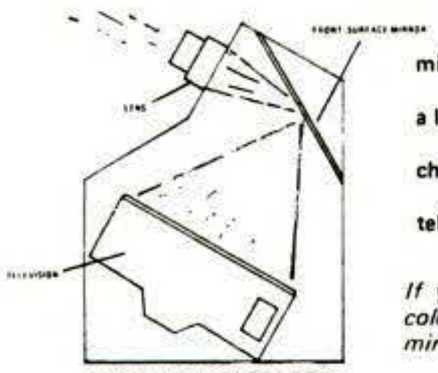

HOW THE LIFESCREEN® PROJECTION SYSTEM WORKS

HOW TO ORDER COMPONENTS

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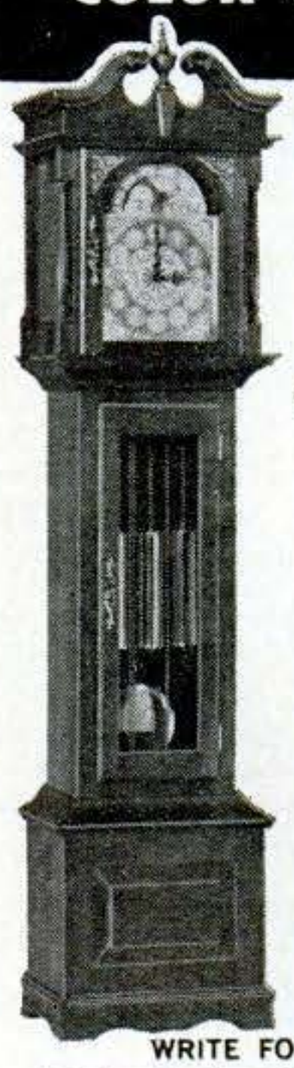

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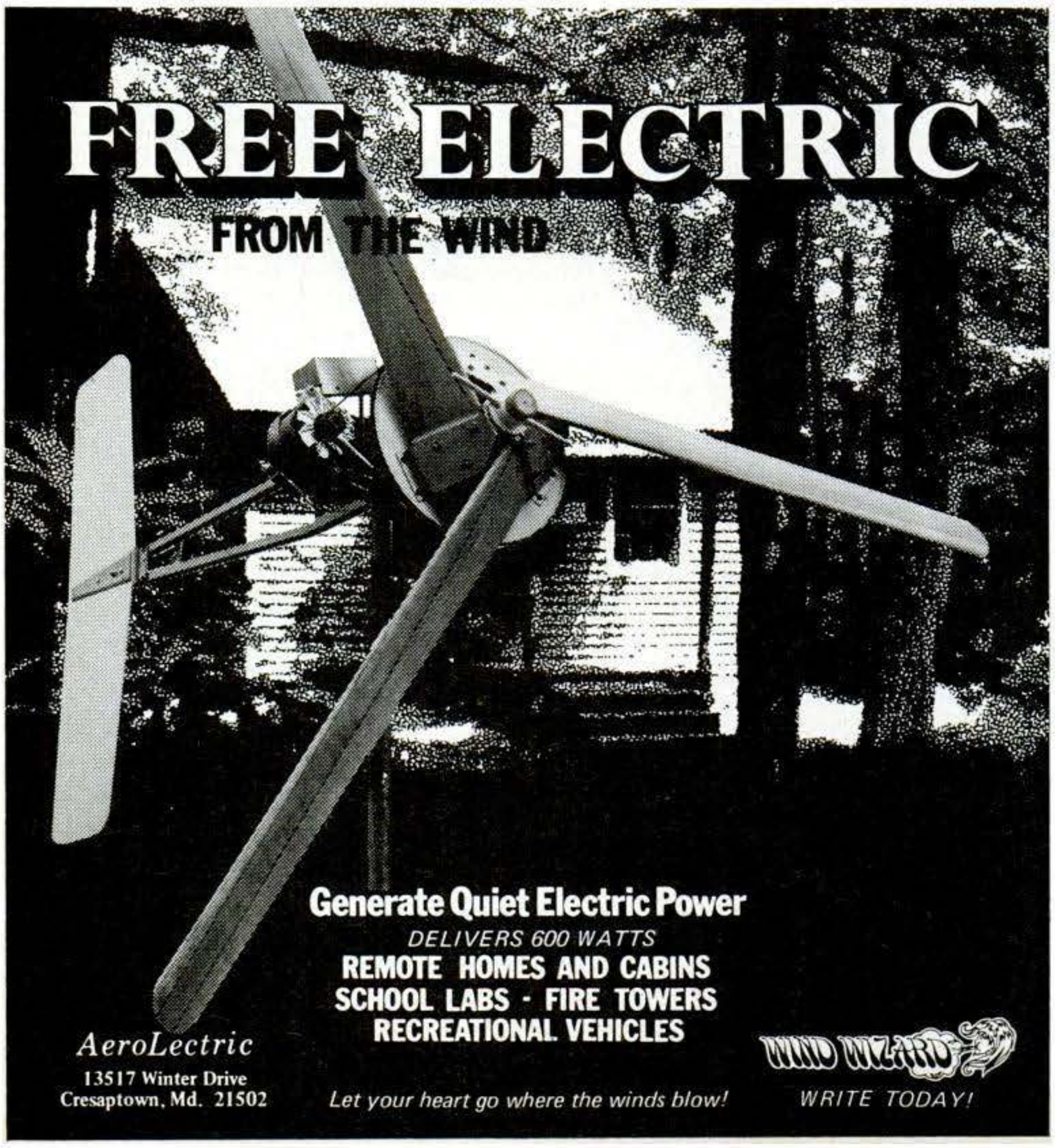

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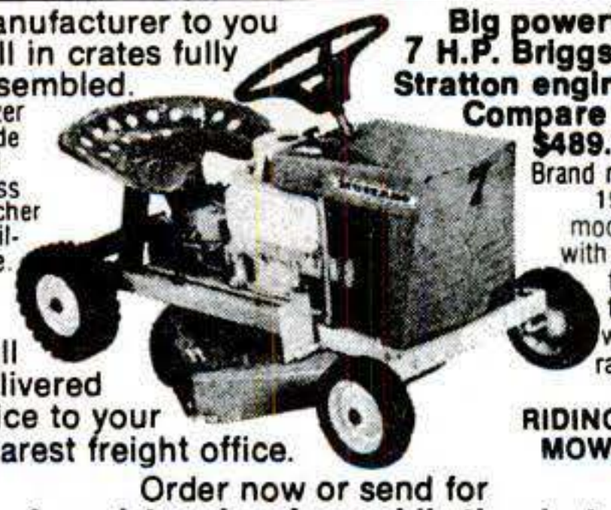

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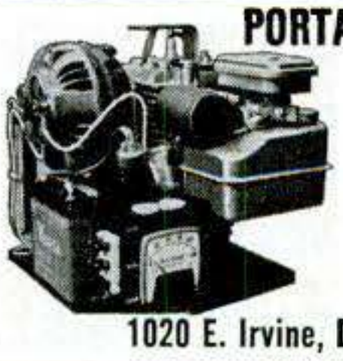

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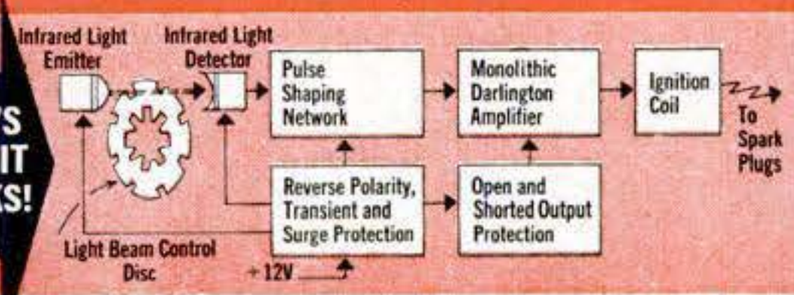

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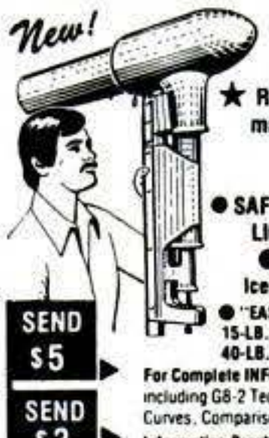

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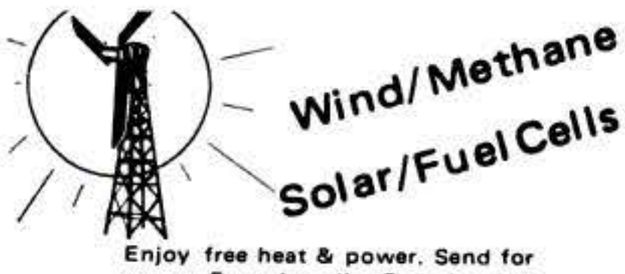

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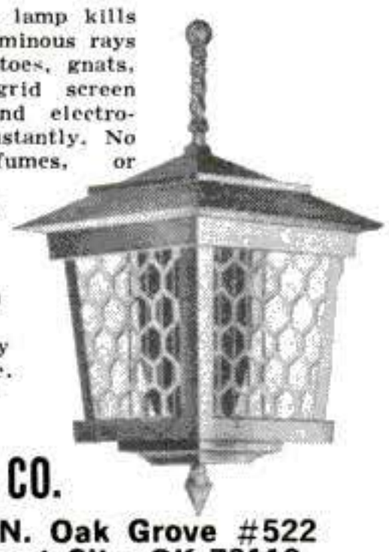

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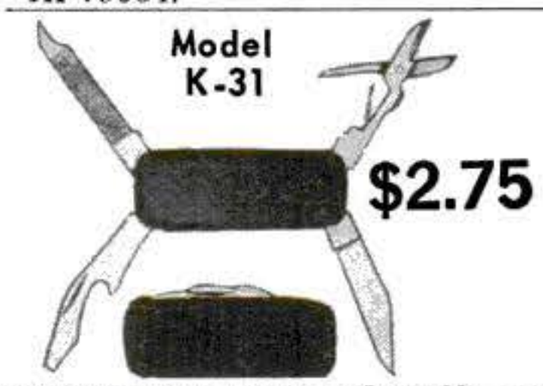

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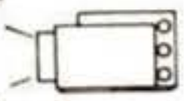

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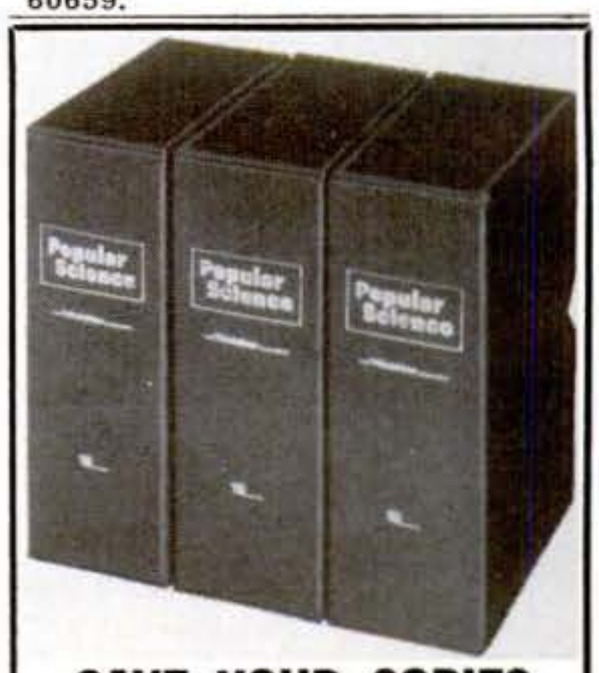

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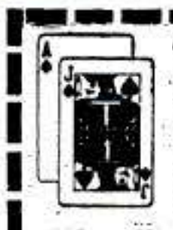

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